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This study measures social vulnerability in the United States Virgin Islands while testing the applicability of a Social Vulnerability Index that was developed for the United States. The main focus was to develop an understanding of the underlying social processes that cause certain people and places to be more vulnerable than others. Using subdistrict level data derived from the 2000 United States Census of Island Areas, a Principle Components Analysis was conducted that identified eight components of vulnerability that accounted for 93.42% of the variance among vulnerability indicator variables in the dataset. The component scores were summed using an additive model to create an index score of vulnerability for each subdistrict within the islands of St. Croix, St. John and St. Thomas. A comparative assessment of social vulnerability among subdistricts was conducted in a Geographic Information System. By mapping both the Social Vulnerability Index scores and the component scores, the most and least vulnerable subdistricts were identified and the underlying social processes contributing toward this vulnerability emerged. Because of the prevalence of less affluent minority groups, St. Croix was found to be the most vulnerable island, whereas St. John was found to be the least vulnerable island due in part to its affluence and cultural homogeneity. In general, subdistricts with densely built environments, large population densities, and a prevalence of low income minority groups and large concentrations of elderly and/or children were found to be more vulnerable than those with smaller population distributions and more affluent, racially and ethnically homogenous communities. A combination of all indicators of social vulnerability, rather than just one indicator, was necessary to define social vulnerability in the US Virgin Islands.

MEASURING SOCIAL VULNERABILITY TO NATURAL HAZARDS:

AN EXAMINATION OF THE UNITED STATES

VIRGIN ISLANDS

by

Carly Hertz Dunno

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Committee Chair

To my wonderful husband. Your love and support has given me the strength I needed to get through this process. I am so blessed to have you as a part of my life.

To my beautiful daughter Addelyn. Your birth (which happened right in the middle of writing this dissertation) was the push I needed to finally complete this stage of my life's journey. Mommy loves you with all her heart.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

Understanding human vulnerability to natural hazards is an important issue in today's world, as natural hazards, over time, have been increasing in frequency and intensity. The potential for loss, whether it be loss of life or material possessions, is exacerbated by ever increasing human development, especially in susceptible locations such as small islands. People historically have been and will always be vulnerable to natural disasters, yet researching the root causes of what makes us vulnerable may help to reduce losses and recovery time proceeding a natural disaster event.

The human-environment interaction is a major focus of research in vulnerability science. The environment is considered the agent of disaster while socioeconomic patterns and societal problems of individuals and/or the community define risk and vulnerability. Vulnerability is defined as the potential for casualty, destruction, disruption, or other form of loss with respect to a particular element and has been regarded as one of the keys to understanding disaster because it is associated with social inequality, past losses and susceptibility to future losses.

In the study of vulnerability, it is thought that social processes generate unequal exposure to risk by making some people more prone to disasters than others. However, vulnerability is not just a property of social groups or of individuals, but is deeply imbedded in complex social relations and processes. In order to understand the complex nature of societal vulnerability, researchers have conducted numerous vulnerability assessments that have the ability to measure vulnerability based on a set of indicators. Measuring social vulnerability of a community is a useful tool for effective public policy, as it has the ability to identify populations most in need of assistance before, during and even after a disaster event.

With the recent emergence of sustainability science, there has been considerable attention paid toward the unique nature of small islands and the issues they face in terms of a sustainable future. The Caribbean region contains many small island developing states that are faced with the challenge of developing sustainable futures. This region in particular is extremely prone to repeated natural disasters, especially those caused by hurricanes. The US Virgin Islands are located within the Caribbean hurricane belt, and have sustained a number of major natural disasters in the past. The Virgin Islands are typically not the hardest hit islands in the region, but when a disaster does occur they often suffer major economic damage.

There has been numerous vulnerability assessments focused on understanding the inherent vulnerability of small-island developing states, and is especially of concern in the Caribbean region. Much of this research has been one-sided in that it either focused on the economic vulnerability or the environmental vulnerability, but not a combination of the two. To date, there have been no social vulnerability assessments conducted in the United States Virgin Islands.

Caribbean small-island developing states are prone to repeated natural disaster events and some people living within these islands are more vulnerable than others due to the various socio-economic characteristics of the population. This research measures social vulnerability to natural hazards in the United States Virgin Islands while testing the applicability of a Social Vulnerability Index that was developed for the United States. The main focus is to develop an understanding of the underlying societal processes that cause certain people and places to be more vulnerable than others. Despite its reputation as an affluent island, the United States Virgin Islands is still extremely susceptible to natural hazard events and has the potential to suffer major losses. Understanding the underlying social structure of vulnerability will lead toward increased resilience to disaster, shorter recovery time after a disaster, and in turn a more sustainable future.

CHAPTER II

LITERATURE REVIEW

The beginnings of hazards research were rooted in the theory of human ecology, which sought to understand the relationship between the natural environment and activities of man (Barrows, 1923). Early on, natural hazards were considered as inevitable and uncontrollable acts of god. Among these hazards are floods, landslides, tornadoes, volcanic eruptions, hurricanes, windstorms, hailstorms, frosts, snowstorms, desertification, earthquakes, and others. These geophysical events were considered hazards when they caused damage to the affected populations (Burton, Kates & White, 1978).

The majority of early geographic approaches focused on the individual hazards common in specific environments and their impacts on people and communities. Additionally, geographers were concerned with predicting the probability of these phenomena. This gave rise to the development of risk assessment: the assessment of the risk of a certain hazard occurring in a given place. For instance, the earliest hazards work in geography was geared toward developing specific methods for assessing both environmental variables and the responses of the affected populations.

Two seminal works in this area were *Risk assessment of environmental hazards* (Kates, 1978) and *Environmental risk assessment* (White & Burton, 1980). In both works, the main concepts were risk and hazard, with hazard being the phenomenon studied and risk being the perspective in which the approach to the problem was placed. Several models were conceived that attempted to explain the behavior and rationality of individuals living in hazard prone areas. Although, the main focus was on minimizing uncertainty through hazard and risk prediction it was considered essential to be able to measure the probability of occurrence of certain hazards, in order to reduce the frequency and intensity of such events.

Additional work examined how people perceived the hazard event, how people perceived the range of adjustments open to them, and what factors accounted for the differences in people's perceptions (Kates, 1971). It was thought that the central component to reducing risk and minimizing losses lay with people's responses to hazard events. "Response to hazards is related both to perception of the phenomena themselves and to awareness of opportunities to make adjustments" (Burton et al., 1978, p.35).

However, the 1970s and 1980s marked a paradigm shift within hazards research, as early work was largely criticized for its limited scope. For example, anthropologists argued that early research did little to explain disaster in third world contexts, and that disaster research should instead be approached from a political-economic perspective where "the root causes of disasters lay more in society than in nature" (Oliver-Smith, 1996). Although geographers have always focused on the human dimension simultaneously with the physical dimension, these new concerns gave more direct attention to socioeconomic patterns and societal problems.

Building upon this new understanding that natural disasters are no longer just about the hazard event and its affect on populations, the focus of research has shifted towards an understanding of the societal and human-environment interactions that precede disasters (Hewitt, 1983). Accordingly, disaster literature regarded the environment as an agent of disaster or hazard, in that risk and disaster are embedded within the natural environment, technology, or the built environment and individuals and/or communities can become victims of extreme events (Burton et al., 1978; Hewitt, 1995, 1997). According to Oliver-Smith (1996) “disasters occur at the interface of society, technology, and environment and are fundamentally the outcomes of the interactions of these features” (p.303).

The current view of hazards is that they are basic elements of environments and are constructed features of human systems rather than extreme unpredictable events, as they were traditionally perceived. This new view that hazards and disasters are an integral part of environmental and human systems allows societal adaption and sustainability to be tested. It is also within this viewpoint that vulnerability studies have emerged.

2.1 Key Definitions

In order to understand the complex relationship between hazards and society, it is important to understand the four key elements: hazards, risk, vulnerability and disaster. Each of these key elements has its place in the literature (e.g. hazards and risks in geography, disaster in sociology and psychology, and vulnerability with a cross-disciplinary approach) and there has often been confusion relating to the definitions. Although, the focus of this research is on vulnerability to natural hazards, an understanding of all key parts is necessary.

2.1.1 Natural Hazards

Natural hazards are extreme geophysical events that are capable of causing disaster. The term “natural” distinguishes such phenomena from technological hazards-including explosions, release of toxic materials, structural collapses, severe contamination, and transportation, construction and manufacturing accidents-and from social hazards such as crowd rushes, riots and terrorist incidents. However, it has been argued that “natural” hazard is a misleading term, as very little is natural about the phenomena in which the danger results largely from human decision making, land use and socio-economic activities (Hewitt, 1997). Tobin and Montz (1997) explained that a natural hazard “represents the potential interaction between humans and extreme natural events” (p.5). Accordingly, a natural hazard then can be defined as a threat to society. The hazard exists because of human activities, which are constantly exposed to natural forces.

The fundamental determinants of natural hazards are location, timing, magnitude and frequency. Many hazardous phenomena are recurrent in time and predictable in terms of location. For example, hurricanes typically occur between five and twenty five degrees north and south of the equator and tend to be seasonal phenomena. Hazard events may often be small recurrent events or occasional large scale events that cause disaster. In either scenario, there is a threshold value by which the geophysical phenomenon is capable of causing disaster. This value, however, is dependent upon the human impact of these geophysical forces: vulnerability of people, society and the built environment may alone determine the magnitude at which an event becomes a disaster (Alexander, 2000).

In the traditional linear view of hazards, an extreme geophysical event combines with elements of human vulnerability and risk, tempered by mitigation measures that may be in place, to create the net impact of the disaster. In this case, it is implied that the physical hazard causes the human disaster. But if human vulnerability and risk are regarded as paramount, then the direction of causality is reversed. It is the vulnerability of the human environment that causes disaster through the medium of geophysical hazard events (Hewitt, 1983).

2.1.2 Risk

Risk is defined as the probability that a particular level of loss will be sustained by a given series of elements as a result of a given level of hazard impact. The elements at risk consist of populations, communities, the built environment, the natural environment, economic activities and services, which are under the threat of disaster in a given area (Alexander, 2000). Risk is equated when vulnerability and hazards combine.

Risk=Hazard x Vulnerability

2.1.3 Vulnerability

Although largely debated, a simple definition of vulnerability is potential for losses or other adverse impacts. People, buildings, ecosystems or human activities threatened with disaster are vulnerable. The literature on risk and vulnerability often confuses the distinction between the two concepts. Vulnerability refers to the potential for casualty, destruction, damage, disruption or other forms of loss with respect to a particular element. Risk combines this with the probable size of impact to be expected from a known magnitude of hazard. Thus, risk is considered as the manifestation of the agent that produces the loss. For example, building an unprotected facility next to a stream that is liable to flood creates both a situation of risk (probable flood damage) and an element of vulnerability (threatened property) (Alexander, 2000). Vulnerability has been regarded as one of the keys to understanding disaster because it is associated with social inequality, past losses and susceptibility to future losses (Alexander, 1997).

2.1.4 Disaster

Disasters mark the interface between an extreme physical phenomenon and a vulnerable human population (O'Keefe, Westgate & Wisner, 1976). Disasters are typically singular, large scale, high impact events and are different from hazards and risks. According to Alexander (2000),

> in social terms, a disaster is a non-routine event but a routine social problem, because disasters are recurrent and because they can at least be anticipated, even if they cannot be predicted (p.21).

Because the root causes of disasters lay more in society than in nature, it makes sense to study disaster through the theory of vulnerability-the concept in which aspects of society may either reduce or exacerbate the impact of a hazard (Oliver-Smith, 1996).

In summary, natural hazards are extreme geophysical events that are capable of causing disaster. A disaster is an event or process that overwhelms the capacity to resist and recover of a vulnerable social group, economic activity or infrastructure. Risk is the probability of a particular loss and is equated when hazards and vulnerability combine. The concept of vulnerability, then, is the connection between people and their environment as well as the social and economic factors that produce susceptibility to specific types of environmental hazards. Vulnerability is deeply imbedded into the social, economic and demographic fabric of society, and when combined with a natural hazard can lead to disaster (Hewitt, 1983). Thus, the theory of vulnerability is the prevailing concept through which disasters should be studied.

2.2 Vulnerability Research

The definition of vulnerability is highly debated, but the commonalities derived from a number of definitions is that vulnerability refers to the characteristics of a person or a group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a hazard event (Alexander, 1997, 2000; Hewitt, 1983; Oliver-Smith, 1996; Wisner, Blaikie, Cannon & Davis, 2004).

Cutter (1996) explained that the broadest definition of vulnerability infers a potential for loss, yet does not define the type of loss and whose loss is being described. Thus, she identified the following three terms: individual vulnerability; social vulnerability; and vulnerability of place. Individual vulnerability infers that there is personal or individual potential for losses, while social vulnerability includes the susceptibility of social groups, or an entire society, to potential losses from hazard events and disasters. Vulnerability of place refers to the

> potential for loss derived from the interaction of society with biophysical conditions which in turn affect the resilience of the environment to respond to the hazard or disaster as well as influencing the adaptation of society to such changing conditions (p. 530).

In the study of vulnerability, it is thought that societal processes generate unequal exposure to risk by making some people more prone to disasters than others. According to Cannon (1994),

> critical to discerning the nature of disasters, then, is an appreciation of the ways in which human systems place people at risk in relation to each other and to their environment-a relationship that can best be understood in terms of an individual's, a household's a community's or a society's vulnerability (p.2).

Vulnerability is, however, not just a property of social groups or of individuals, but is deeply imbedded in complex social relations and processes. Vulnerability represents the physical, economic, political or social susceptibility of a community (or individual) to a damaging or destabilizing phenomenon. Thus, vulnerability to natural hazards is integrally related to the prevailing socio-economic and environmental conditions.

Downing and Bakker (2000) listed the central concepts of vulnerability as follows:

- Vulnerability is a relative measure and critical levels of vulnerability must be defined.
- Everyone is vulnerable, although their vulnerability differs in its causal structure, its evolution, and the severity of the likely consequences.
- Vulnerability relates to the consequences of a perturbation, rather than its agent. Thus, people are vulnerable to loss of life, livelihoods, assets and income, rather than to specific agents of disaster, such as floods, windstorms or technological hazards. This focuses vulnerability on the social systems rather than the nature of hazard itself.
- The locus of vulnerability is the individual related to social structures of household, community, society and world-system. Places can only be ascribed a vulnerability ranking in the context of the people who occupy them.
- Vulnerability is spatially and temporally variable. Vulnerable groups are dispersed over space and change over time. More critically, patterns of vulnerability depend on geographical linkages and are often contingent on past conditions.

2.3 Themes in Vulnerability Research

There are three distinct themes in the conceptualization of vulnerability. The first identifies vulnerability with the potential exposure to a physical hazard. Studies from this perspective focus on distributions of hazardous conditions and on the ways that these conditions affect people and structures. The hazards perspective treats differential vulnerability of people, structures and activities as irrelevant or incidental in disasters. Variables used to assess such physical vulnerability normally include proximity to the source of threat, incident frequency or probability, and magnitude, duration, or spatial impact of particular hazards. Some examples of research following this approach are (Alexander, 1993; Fedeski & Gwilliam, 2007; Hewitt and Burton, 1971; Heyman, Davis & Krumpe, 1991; Quarantelli, 1992).

The second perspective on vulnerability takes exposure as a given and searches for the patterns of differential losses among people affected. This second perspective has been referred to as the study of social vulnerability in that it emphasizes the social dimensions of vulnerability (Adger, 1999). These studies focus on potential coping ability of individuals or communities, including the ability to withstand the damaging effect of a hazard (i.e. resistance) and the ability to recover quickly from damage caused by a hazard (i.e. resilience). The social vulnerability perspective places emphasis upon understanding how communities are exposed to dangers or become unsafe, rather than the traits of the geophysical agents themselves. When people are in danger, the main concern is with their coping strategies rather than the severity of a damaging agent, and when disasters do occur, the focus is especially upon who is affected and their ability to withstand, mitigate and recover from damage. In this perspective, society, rather than nature, is the deciding factor of who is more likely to be exposed to harm or to have weakened or no defenses. Therefore, hazards act as agents that reveal pre-existing weaknesses in a society through means of a disaster. Examples of research following this approach are (Blaikie et al., 1994; Bohle, Downing & Watts, 1994; Chambers, 1989; Chen, 1994; Clark et. Al., 1998; Downing, 1991; Hewitt, 1997; Susman, O'Keefe & Wisner, 1983; Yarnal, 1994).

Based on the two prevailing trends in the literature, Cutter (1996) and Cutter, Mitchell and Scott (2000) formalized a third approach, vulnerability of place, which combines elements of the two, yet is more geographically centered. In this perspective, vulnerability is considered as both a biophysical risk as well as a social response, but within a specific areal or geographic domain. Vulnerability is studied within a geographic space to identify where vulnerable people and places are located, or within a social space to identify who in those places are most vulnerable. There have been a number of studies to use an integrative place-based vulnerability approach in a wide array of spatial contexts, ranging from the national to local level (Blaikie and Brookfield, 1987; Boruff, Emrich & Cutter, 2005; Clark et al., 1998; Cross, 2001; Degg, 1993; Kelly and Adger, 2000; Liverman, 1986, 1990b; Longhurst, 1995; Mitchell, Devine & Jagger, 1989; Palm, 1990; Wilhite and Easterling, 1987; Wu et al., 2002).

2.4 Theoretical Constructs of Vulnerability

In order to develop an understanding of a society's vulnerability, a detailed analysis of all components that influence vulnerability must be addressed. These components include the socio-demographic characteristics of the population, the political economy of the society and the biophysical components of the hazard. There have been only a few attempts to combine all of these elements into a theoretical construct for measuring vulnerability. The following five models are those that have been used to measure and define vulnerability within the hazards literature: Pressure and Release Model, Hazards Dimension Model, Human Ecology of Endangerment Model, The Vicious Circle of Vulnerability Model, and the Vulnerability of Place Model.

2.4.1 Pressure and Release Model

Blaikie, Cannon, Davis and Wisner (1994) developed the Pressure and Release Model (PAR), which explains the relationship between disaster and vulnerability. The PAR identified the root causes of vulnerability as well as the various components of a society that amplify vulnerability. According to the PAR, the natural progression of vulnerability is threefold. First, the root causes of vulnerability are determined by limited access to power, structures and resources along with ideologies of the political and economic systems. Second dynamic pressures such as lack of local institutions, skills, local investments and markets and macro-forces such as rapid population change, urbanization, deforestation and government debt to revenue ratios combine to exacerbate the level of vulnerability. Third, unsafe conditions in the physical environment (e.g. unprotected buildings and infrastructure), local economy (e.g. low income and at risk livelihoods), social relations (e.g. social inequality of certain groups), and public actions (e.g. lack of disaster preparedness) combine to create the overall vulnerability of individuals and/or communities.

Additionally, Blaikie and others (1994) presented the “access” model, which is a component of the PAR model. The “access” model proposed that unsafe conditions in a society are due to the economic and political processes that compose that society. In other words, it is the political and economic processes that determine allocation of resources within a society, which in turn has an effect on the level of vulnerability within that society. Thus, policy implications are incorporated within the model to determine vulnerability.

2.4.2 Hazard Dimensions Model

In an effort to develop a contextual framework for future hazards research, Tobin and Montz (1997) synthesized all previous theoretical work into their hazard dimensions model. This model takes an integrative approach to the study of hazards and vulnerability in which physical, economic and social characteristics of hazards are combined. The common elements within each hazard characteristic have been identified based on previous research. For example, the physical characteristics of natural hazards should be studied in the context of magnitude, frequency, duration, spatial extent, seasonality and countdown interval. The key political and economic factors are broken down into individual characteristics (i.e. proximity to hazard source, type of structure, level of empowerment, and range of choice) and societal characteristics (i.e. land use patterns, distribution of wealth, resource management patterns in history and level of development). The third dimension of hazards is societal characteristics, which are identified as gender, age, education, family structure, length of residence, occupation and tenure. It is the combination of these factors that defines vulnerability and presents the context in which vulnerability should be studied. The model also places the hazard dimensions of human response in context by incorporating loss reduction options such as perception and mitigation strategies.

2.4.3 Human Ecology of Endangerment

Hewitt (1997) proposed a model of vulnerability in which he termed “human ecology of endangerment.” This model takes into account the societal characteristics that influence vulnerability as well as their geographic distribution. The human ecology of endangerment model is comprised of three parts: forms of vulnerability, loci of vulnerability, and syndromes (i.e. assumed determinants) of vulnerability. The various forms of vulnerability included in the model are exposure to hazards, structural weaknesses and susceptibility, defenselessness in terms of lack of protection or aid, lack of response capabilities and powerlessness. Loci of vulnerability such as gender, culture and ethnicity, and type of social space represent the characteristics within a society that affect vulnerability. Furthermore, the political economy and level of development of a society are assumed determinants of vulnerability. Geographic space is also incorporated within each proposed component of vulnerability.

2.4.4 The Vicious Circle of Vulnerability Model

Alexander (2000) presented a feedback loop model, termed “the vicious circle of increases in vulnerability: a process of positive feedback,” which sought to explain the increasing level of vulnerability. His model depicted how choices made by politicians, planners and developers increased the vulnerability of human populations through unprotected development and lack of mitigation. There are processes that both positively and negatively affect the level of vulnerability, resulting in a positive feedback loop. Alexander’s model also incorporated outside influences, such as scientific research on disasters and political corruption, which could affect the circle of vulnerability.

2.4.5 Vulnerability of Place Model

The vulnerability of place model (VPM) presented first in Cutter (1996) and later in Cutter, Mitchell and Scott (2000), integrates both biophysical vulnerability and social vulnerability to determine the overall vulnerability of a place. In this model, risk interacts with mitigation measures to produce the hazard potential. The hazard potential, then, is either lessened or amplified by the social fabric of the society (i.e. social vulnerability). Included within the social fabric are socio-demographic characteristics and capacity to respond to hazards. Additionally, the site and situation of the place as well as the proximity to the source of the event interact with the hazard potential (i.e. biophysical vulnerability). There is also a feedback loop incorporated into the model, which allows for the enhancement or reduction of risk, leading to either increased or decreased vulnerability.

2.4.6 Summary of Theoretical Constructs

The PAR model (Blaikie et al., 1994) addressed a multitude of societal characteristics that influence vulnerability, yet it lacks the ability to analyze vulnerability to multiple hazards. The PAR model also lacked a feedback mechanism for policy and mitigation efforts. The access model also proposed by Blaikie and others (1994) did allow for the integration of policy practices that can affect vulnerability, yet it still lacked the ability to incorporate mitigation strategies and an analysis of multiple hazards. On the other hand, Tobin and Montz's hazard dimensions of vulnerability model (1997) allowed for the integration of physical and social dimensions of vulnerability, along with a human response element that integrates perception and mitigation strategies.

Hewitt's model of human ecology of endangerment (1997) allowed for the incorporation of all aspects of vulnerability within a society, including the political economy, socio-demographic characteristics and level of development. The only element lacking in his model was a mechanism for feedback that could either decrease or increase vulnerability based upon policy and mitigation practices. Alexander's circle of vulnerability model (2000) was theoretical grounded in policy and development practices, yet it completely omitted the socio-economic characteristics that affect a society's vulnerability.

Finally, Cutter's vulnerability of place model (1996) was the only model that had the ability to compare vulnerability among geographic regions. The VPM not only includes the two main components of social and biophysical vulnerability, but it also has the ability to analyze how these characteristics interact spatially.

2.5 Vulnerability Assessments

Birkmann (2006) explained that along with a paradigm shift from hazard analysis to vulnerability assessment, there is a need to measure vulnerability and develop indicators to reduce risk and the vulnerability of at-risk societies.

> The ability to measure vulnerability is increasingly being seen as a key step towards effective risk reduction and the promotion of a culture of disaster resilience. In the light of increasing frequency of disasters and continuing environmental degradation, measuring vulnerability is a crucial task if science is to help support the transition to a more sustainable world (p.9).

The works of Mitchell, Devine and Jagger (1989) and Palm (1990) combined both empirical and social analyses in hazard studies, with geographic scale as a central component, concluding that hazards are complex, multidimensional physical and social phenomena needing to be examined at various geographic scales.

Vulnerability assessments have been conducted at various scales, ranging from the global, (World Bank, 2006) to the national, (Cutter, Boruff & Shirley, 2003; Cutter & Finch, 2008) regional, state and local levels (Boruff et al., 2005; Chakraborty, Tobin & Montz, 2005; Cross, 2001; Flax et al., 2002; Kelly & Adger, 2000; Odeh, 2002; Wu et al., 2002).

In 2006, the World Bank published a series of case studies that identified natural hazard hot spots throughout the world. The Hotspots initiative was focused on reducing disaster losses by identifying geographic areas that are most vulnerable to hazards. The major conclusion from these studies was that scale matters. Geographic areas that are identified as hotspots at the global scale may have a highly variable spatial distribution of risk at finer scales. Additionally, scale affects data availability and quality. More comprehensive, better quality data permit more complete, accurate and reliable identification of multi-hazard hotspots at finer scales of resolution. Additionally, the study concluded that better data resolution and a richer set of variables contribute to results that are more relevant for national-to-local scale risk management planning. Global and local scale analyses were considered to be complimentary in that national-to-local level risk assessments may be downscaled from global data for finer-scale risk assessment to compensate for lack of local data. Ideally, however, global analyses would be scaled up-generalized from more detailed larger-scale data.

Research has suggested that studying vulnerability at a more finite scale may be more beneficial, because it enables a more comprehensive understanding of the fabric of society and thus its inherent vulnerability. Wisner and Luce (1993) explained that scale is an important factor in reducing vulnerability. For instance, vulnerability can be characterized by cities or metropolitan areas, whole nations or even regions of the world. However, an assessment of vulnerability in daily life is what allows planners to develop short and medium term plans and demands in disaster situations.

> It is tempting to assume that reducing vulnerability at, say, the national level automatically reduces vulnerability among social groups, households and individuals in that nation. That is certainly not the case (p.128).

The measurements chosen must be done in a pragmatic way, meaning that indicators of vulnerability cannot be chosen at random, but with reference to assumptions about underlying societal processes.

Kelly and Adger (2000) assessed vulnerability to climate change in coastal Vietnam by analyzing patterns in response at both the household and community level. Cross (2001) assessed the differences in hazard vulnerability between small towns and large 'megacities,' concluding that while megacities have a higher probability of experiencing a hazard event, it is the smaller cities that have a higher probability for sustaining losses due to the proportionality of the population affected.

Flax, Jackson and Stein (2002) explained that a comprehensive risk and vulnerability assessment (RVA) is necessary to create more resilient communities to natural hazards. Various United States based research initiatives on risk and vulnerability assessments have stemmed from the Disaster Mitigation Act of 2000, in which the Federal Emergency Management Agency (FEMA) has mandated states to submit Standard State Mitigation plans that include an RVA by November of 2003.

These plans must be approved by FEMA in order for a state to become eligible for disaster recovery funding. Flax and others (2002) argued that while state-based RVAs are necessary for national policies, a community level vulnerability assessment is more beneficial for decision making at the local, or “grass-roots” level. The Community Vulnerability Assessment Tool (CVAT) was designed by the National Oceanic and Atmospheric Administration’s Coastal Services Center to assist emergency managers and planners with mitigation strategies. The CVAT methodology incorporated data on economic, social and environment factors influencing community-level risk and vulnerability.

Wu, Yarnal and Fisher (2002) used a GIS-based methodology to assess vulnerability of Cape May County, New Jersey to sea-level rise. Physical hazard data was combined with social vulnerability data in a GIS database to produce vulnerability maps. Boruff and others (2005) assessed erosion hazard vulnerability of coastal counties in the United States by combining erosion data from the USGS with socioeconomic data from the US Census. It was determined that a more detailed understanding of place vulnerability would be beneficial if scaled down to the sub county level.

Cutter, Boruff, and Shirley (2003) created the social vulnerability index (SoVI) as a construct to measure social vulnerability to environmental hazards within the United States. They collected socioeconomic data for all 3,141 counties. The data were obtained from the U.S. Census Bureau for the year 1990, and were representative of characteristics within a society that may influence its vulnerability. The data were collected for over 250 variables, but after testing for multicollinearity, a subset of 85 variables was derived. These 85 variables were normalized (to percentages, per capita, or density functions), leaving 42 independent variables for analysis. Using principle components analysis on 42 variables of county-level socioeconomic and demographic data, they were able to identify 11 factors that accounted for 76.4 percent of the variance in social vulnerability for each of the counties in the United States. The factor scores were then imputed into an additive model to compute the social vulnerability index score (SoVI) for each county. "The SoVI is a relative measure of the overall social vulnerability for each county" (p.254). No weights were assigned to the factors, as they were viewed as having an equal contribution to the county's overall vulnerability. Additionally, the factors were scaled so that positive values indicated higher levels of vulnerability and the negative values indicated lower levels of vulnerability. The SoVI scores were then mapped based on standard deviations from the mean to identify the range of vulnerability within the counties of the U.S.   SoVI has been one of the only attempts at creating a broad comparative indicator of social vulnerability at the county level for the entire United States.

Cutter and Finch (2008), examined how overall social vulnerability has changed over time and space by examining spatial and temporal patterns of social vulnerability in the United States from 1960 to the present. Using county-level data on historical variability in natural hazard vulnerability, the authors concluded that population change and population density have a significant impact on the temporal trends of social vulnerability. The methodology used in this research explains shifts in vulnerability over time and space for counties in the United States. The Social Vulnerability Index is to date the most robust and generalizable index for measuring social vulnerability to natural hazards. However, this methodology has been mainly applied within the United States.

A recent study by Schmidtlein, Deutsch, Piegorsc and Cutter (2008) tested the sensitivity of SoVI to changes in geographic scale and minor changes in the variable set. To test how scalar changes impact analysis, the authors varied data collected from counties to census tracts. It was hypothesized that decreasing the level of aggregation from the county level to the census tract level would yield a decrease in the amount of variance explained by the Principle Components Analysis used to construct the index. It was found that as the level of aggregation decreased, the variance explained decreased, and the number of components selected increased. According to the authors,

> this suggests that while scalar changes affect the PCA analysis and the numeric properties of the index, the identification of the drivers of vulnerability within a study area, based on a constant variable set, are not strongly dependent on the scale of aggregation used to define the study area (p.1110).

Additionally, the authors tested the sensitivity of the index algorithm to changes in the input variables. They compared results using the original 33 variables included in SoVI with a second analysis using only 26 variables. The PCA performed on the original dataset yielded eight components explaining 85.8 percent of the variance of the original data, whereas the PCA performed on the subset of 26 variables led to six components explaining 85 percent of the data variance. When testing the ranked SoVI scores, only 12 of the 42 counties had rank changes of 10 or greater, and only two counties had low enough value changes to move them from lower to higher, or higher to lower, vulnerability status.

Vulnerability assessments have been conducted at many different spatial scales, ranging from the global to the community level. Each scale of analysis has the ability to shed light on what makes places and people living within those places vulnerable. However, it has been concluded by some that a more finite scale is beneficial for truly understanding the fabric of society and its inherent vulnerabilities.

There have been a plethora of methodologies developed for conducting vulnerability assessments. Again, there is not one definitive way to conduct a vulnerability assessment, yet some methods have proven more successful than others. Birkmann (2006) explains that because the concept of vulnerability is multidimensional and difficult to define, it is even more difficult to develop a universal measurement methodology. Thus, there are various techniques and methodologies for measuring vulnerability at different scales and different geographies that have been deployed in the literature. He argues that indicators are key tools for identifying and measuring vulnerability. A set of indicators may be developed from gatherable data that will allow for an estimation of vulnerability. It is important to note that arguments have been made that vulnerability is so complex that it is often difficult to measure and quantify. Additionally, indicators may oversimplify the complex interactions that shape various vulnerabilities. Morse (2004) argued that indicators are necessary tools, yet they must be handled with care.

2.5.1 Indicators of Vulnerability

There is a large body of work dedicated toward identifying the factors that influence social vulnerability. According to Cutter, Boruff and Shirley (2003), a general consensus exists among those in the social science community as to the major factors that influence vulnerability. Included are lack of access to resources; limited access to political power and representation; social capital, including social networks and connections; beliefs and customs; building stock and age; physically limited individuals; and type and density of infrastructure.

A wide variety of variables identified as indicators of social vulnerability include gender (Enarson & Morrow, 1998; Morrow & Phillips, 1999), age (Hewitt 1997; Ngo, 2001; O'Brien & Mileti, 1992), disability (Morrow, 1999; Tobin & Ollenburger, 1993), family structure and social networks (Blaikie et al., 1994; Morrow, 1999), housing and built environment (Bolin & Stanford, 1991; Quarantelli,1992), income and material resources (Bolin & Stanford, 1991), and race and ethnicity (Bolin, 1993; Peacock, Morrow and Gladwin 1997; Pulido, 2000). As Cutter (1996) explains, although the vulnerability indicators are often single variables, they are manifestations of multidimensional factors such as institutional development, social relations, or political power. A subset of studies examining social vulnerability go beyond the assessment of vulnerability indicators and aim to explain how the vulnerable conditions are rooted in historical, cultural, and economic processes that impinge upon the individual's or society's ability to cope with disasters and to respond to them (Blaikie et al., 1994; Watts & Bohle, 1993).

A research endeavor conducted by Morrow (1999) examined a number of recent disasters in order to identify how certain categories of people are at more risk than others. Her assessment was conducted at the individual household level to look for combinations of risk factors that may otherwise go unnoticed in a larger scale assessment. She explained that it is not just about the relationship between, for example, poverty and vulnerability but the combination of certain physical and social attributes (e.g. age, race, ethnicity and gender) and living arrangements (e.g. single-parent households) that are likely to be associated with limited resources and power that increase a person's vulnerability in the face of disaster.

The most widely accepted characteristics influencing vulnerability are age, gender, race and socioeconomic status. Others included in the literature are special needs populations (such as the physically and mentally challenged), immigrants that do not speak the language, the homeless, transients and seasonal tourists. Additionally, quality of human settlements (housing type and construction, infrastructure and lifelines) and the built environment also play a major role in community-level vulnerability.

2.5.2 Vulnerability Assessments of Small-Island Developing States

Small island developing states (SIDS) are vulnerable to natural hazards for many of the same reasons as larger or continental developing states (e.g. a colonial history, reliance on primary exports, extremes of poverty or inequality, limited physical and social infrastructure, inappropriate land use and weaknesses in governance and public administration). Yet, they face other intrinsic problems including small size, insularity and remoteness, environmental factors, limited disaster mitigation capability, and demographic and economic structures (Pelling & Uitto, 2001).

There is a growing body of research focusing on the inherent vulnerabilities of small island states, with respect to climate change, environmental degradation, lack of resources and global economic pressures (examples of which include Boruff & Cutter, 2007; Briguglio, 1995; Cross, 1992; Gowrie, 2003; Lewis, 1990; Mossler, 1996; Pelling & Uitto, 2001; Pernetta, 1992; Turvey, 2007).

Research on the vulnerability of SIDS to natural hazards has progressed from the description of historical hazards events (Cross, 1992), and an examination of factors contributing to vulnerability associated with global climate change (Lewis, 1990), to quantitative analyses that examine the various indicators for identifying small island vulnerability (Boruff & Cutter, 2007; Briguglio, 1995; Gowrie, 2003; Pelling & Uitto, 2001; Turvey, 2007).

The first attempt to quantify small-island vulnerability was conducted by Briguglio (1995), in which he hypothesized that the higher the incidence of exposure to foreign economic conditions, insularity and remoteness, and proneness to natural disasters in a given country, the higher the degree of vulnerability in the same country. The results of his study confirmed that in terms of economic vulnerability to natural hazards, Small Island Developing States tended to be more vulnerable than other groupings of countries, and in general SIDS registered higher vulnerability scores than developing countries.

In 2001, Pelling and Uitto presented a framework for measuring small island vulnerability using indicators of global economic change. They argued that global changes influence local resilience to natural disasters in the form of new opportunities and/or constraints. Their analyses confirmed that small islands are made vulnerable by their small size, insularity and remoteness, environmental factors, limited disaster mitigation capability, and demographic and economic structure. The larger and least globally connected island states were those most severely affected by disaster, although it is the smaller islands that are most at risk from total destruction by a single disaster event.

Environmental vulnerability is another widely studied topic with respect to small islands. For example, the South Pacific Applied Geoscience Commission (SOPAC) created the Environmental Vulnerability Index (EVI), which was designed to reflect changes in the natural environment of a country that make it prone to damage and degradation in the future. The EVI does not, however, have the ability to measure the social, cultural and economic environment. Gowrie (2003) extended the work of SOPAC, which at the time was only calculating EVIs for islands in the South Pacific, to include the island of Tobago in the West Indies.

A number of studies have identified the need for an integrative approach to environmental hazard analysis of small islands (eg. Bender, 1989; Lewis 1984, 1990; Mossler, 1996; Pernetta, 1992; Tomblin, 1981; Vermeiren, 1991). Applications of integrative approaches to analyzing vulnerability combine elements of social, economic and geophysical factors.

In 2007, Turvey identified a lack of systematic empirical studies linking geographic theory with vulnerability assessment of developing countries, particularly in reference to small-island developing states. Thus, she developed a methodology which combines social elements (i.e. vulnerable groups of people living in vulnerable places), spatial elements (i.e. vulnerable places), and temporal elements (e.g. time-specific configurations) for assessing vulnerability.

Boruff and Cutter (2007) identified a lack of understanding concerning the methods for identifying vulnerability within or between places, especially small-island developing states. To help remedy this problem, they followed the framework of the Social Vulnerability Index (Cutter et al., 2003) to measure vulnerability within and between the islands of Saint Vincent and Barbados. It was concluded that it is the combination of social and physical indicators that affects island vulnerability, thus providing a starting point for additional research on the spatial assessment of Caribbean island vulnerability.

There have been several methods developed for analyzing vulnerability within small island developing states. However, most methods have been one-sided in that they either have the ability to assess economic vulnerability or environmental vulnerability, but not a combination of the two. Both studies by Turvey (2007) and Boruff and Cutter (2007) attempted to bridge this gap by using an integrative approach in their assessments of small islands, combining elements of economic, social and physical vulnerability at different scales of analysis. Turvey (2007) conducted her vulnerability assessment at the global scale, comparing place vulnerability of less developed countries with special reference to small island developing states, while Boruff and Cutter (2007) analyzed the spatial distribution of vulnerability between the two Caribbean island nations of Barbados and St. Vincent. Despite these two studies, there remains a lack of research combining geographic theory with vulnerability assessment methodologies at different spatial scales.

2.6 Vulnerability in the Caribbean

Vulnerability to natural hazards within the Caribbean region has long been a concern of researchers. Much of the early literature on natural hazards in the Caribbean was largely descriptive in nature discussing everything from the types of hazards that occur in the region and their spatial and temporal distributions (Eyre, 1987; Lewis, 1984; McCann, 1985; Tomblin, 1981; Wright, 1966) to the effects on society and the physical environment (Cross, 1992; Gajraj, 1981; Hammerton, George & Pilgrim, 1983; McIntosh, 1984; Richardson, 1989; Schwartz, 1992; Williams, 1988). More recent research has focused on identifying physically vulnerable locations, but usually with respect to only one type of hazard. Additionally, there have been only a few publications on social vulnerability within the region, and very few studies have attempted to integrate both physical and social characteristics into a vulnerability assessment (Boruff & Cutter, 2007).

2.6.1 Physical Vulnerability in the Caribbean

The identification of the types of natural hazards common in the Caribbean has been well documented. Additionally, there have been a number of studies with a focus on identifying physically vulnerable locations within these island nations. For instance, the Pan Caribbean Disaster Preparedness and Prevention Project first met to analyze the physical factors contributing to vulnerability in the participating Caribbean island nations. Such topics included tsunami and earthquake assessments (Lander, 1987; Shepherd, 1987), volcanic hazard mapping and landslide assessments (Hooper, Mattioli & Kover, 1997; Rogers, 1996) and flood hazard mapping (Molina, 1987).

Recent research endeavors have focused on assessing physical vulnerability to global climate change. The majority of global climate change research has been conducted within governmental organizations (e.g. United Nations Environment Programme, United States Agency for International Development) especially with respect to sea level rise (UNEP, 2002; USAID, 2002). Additionally, the Caribbean Planning for Adaptation to Climate Change Project (CPACC) was developed for the sole purpose of enhancing the capacity of the Caribbean region to adapt to climate change.

Another notable agency researching physical vulnerability in the Caribbean is the Caribbean Disaster Emergency Response Agency (CDERA). CDERA is a regional inter-governmental agency responsible for managing disaster response in the Caribbean Community (CARICOM). The 16 CDERA participating States are Antigua, Anguilla, Barbados, Bahamas, Belize, British Virgin Islands, Dominica, Grenada, Guyana, Jamaica, Montserrat, Saint Lucia, St. Kitts, St. Vincent, Trinidad & Tobago, and Turks & Caicos. In order to manage disaster response in the region, CEDERA maintains a detailed list of vulnerability assessments and data sources for all of its member states (CDERA, 2004). This online database provides the most comprehensive lists of hazard related data for the Caribbean region.

2.6.2 Socio-Economic Vulnerability in the Caribbean

The Pan Caribbean Disaster Preparedness and Prevention Project was one of the earliest gatherings of experts on hazard mapping in the Caribbean. Of the 23 papers discussed at the first meeting in 1987, only two included analyses on socioeconomic indicators of vulnerability.

For instance, Jones (1987) presented an analysis on vulnerability of coastal communities in the Caribbean. Included in her analysis was an integration of both socioeconomic and biophysical indicators of vulnerability. Some of the socio-economic factors assessed were property values, settlement characteristics, dwelling types, and the economic composition of the study areas. Despite being one of the first research endeavors to utilize an integrative approach to vulnerability analysis, this study was lacking in several other key socio-demographic factors of social vulnerability such as gender, age and education.

Croward (2000) conducted an economic analysis of vulnerability for the Caribbean region on behalf of the Caribbean Development Bank. In this study, he used the economic variables of Gross Domestic Product (GDP), consumer prices, merchandise imports and exports, trade balance, net foreign assets, growth in long stay tourism, cruise ship passenger arrivals, external debt and government expenditures to compare levels of vulnerability between Caribbean countries. It was found that natural hazard events had a significant impact on GDP, balance of trade, long-stay tourism and government expenditures in the Caribbean islands.

In 1999, the Organization of American States (OAS), through the Caribbean Disaster Mitigation Project, developed a hazard mitigation and vulnerability reduction plan for Jeremie, Haiti (OAS, 1999). This analysis was one of the few conducted in the Caribbean islands that utilized a multi-hazard integrative approach to studying vulnerability. In addition to examining all types of natural hazards that have the potential to affect Haiti, the study also assessed both physical and socio-economic components of vulnerability. Despite its integrative approach to vulnerability analysis, this study was purely descriptive failing to quantitatively analyze components of vulnerability.

Boruff and Cutter (2007) noted a lack of understanding concerning the appropriate techniques for comparing vulnerability within and between places, especially small-island developing states. Using St. Vincent and Barbados as their study area, they conducted a multi-hazard integrative vulnerability assessment within and between the two Caribbean islands. This research used the theoretical concepts as presented in the vulnerability of place model (Cutter, 1996) to help understand which island had the greater level of vulnerability, and why. All potential physical hazard threats were analyzed for both islands, as well as a number of socio-economic variables of vulnerability. This study utilized the methodology for measuring social vulnerability as presented in Cutter, Boruff and Shirley (2003), which identified socioeconomic status, gender, race and ethnicity, age, development, employment loss, rural and urban, residential property, infrastructure and lifelines, renters, occupation, family structure, education, population growth, medical services, social dependence and special needs as the seventeen broad-based indicators best for measuring the underlying causes of social vulnerability. However, due to data constraints, the researchers developed their own set of socio-economic variables that were closely related to those listed above. This was the first study to develop a framework for comparing levels of vulnerability between the Caribbean islands.

Boruff and Cutter (2007) was the first research endeavor to measure the social component of vulnerability in the Caribbean islands at a small scale using a set of composite indicators. Although it was a step in the right direction, there were a few shortcomings that should be mentioned. The SoVI methodology was used as guidance for selecting the appropriate variables for analysis. However, only the dominant variables identified in Cutter, Boruff and Shirley (2003) were chosen. This is a misstep because the dominant variables explaining the variation in social vulnerability in counties of the U.S. might be completely different from those that explain the variation within Caribbean islands. Additionally, variables that were not explicitly used in the SoVI method were incorporated because they were found to have been important by local emergency preparedness planners. These particular variables (i.e. percentage of housing units possessing radios, televisions, cooking with gas, kerosene or electricity, and lighting with electricity) were categorized within the infrastructure dependence factor. These variables are not among the characteristics generally accepted by social scientists to be representative of social vulnerability, yet they are important from a preparedness standpoint. It begs the question, should preparedness be a measure of social vulnerability?   Finally, due to lack of available data, data from the 1991 census for Barbados and 2000 census for St.Vincent were used. As explained in Cutter and Finch (2008), social vulnerability is highly complex, changing over space and through time. Therefore, it is expected that there is an inability to compare vulnerability scores between the two islands of Barbados and St. Vincent because the data represented different time periods. Had they been taken from the same year, the comparability of social vulnerability between Barbados and St. Vincent would be more accurate. Despite these few shortcomings, this research has laid the groundwork for future vulnerability assessments in the Caribbean.

CHAPTER III

METHODOLOGY

3.1 Overview

This chapter describes the methods used to assess social vulnerability to natural hazards in the U.S. Virgin Islands. It begins with an overview of the study area, which includes justification for choosing the U.S. Virgin Islands along with a brief description of the demographic, economic and physical characteristics of these islands. The following sections also detail the analyses used in the study to test the applicability of the Social Vulnerability Index methodology (Cutter, Boruff & Shirley 2003) in an island context and the comparative assessment of social vulnerability within and between the islands of St. Croix, St. John and St. Thomas.

3.2 Study Area

With the recent emergence of sustainability science, there has been considerable attention paid toward the unique nature of small islands and the issues they face in terms of a sustainable future. One of the most common factors influencing sustainability is proneness to natural disasters and the inherent vulnerability. The Caribbean region contains many small island developing states that are faced with the challenge of developing sustainable futures. This region in particular is extremely prone to repeated natural disasters, especially those caused by hurricanes. The U.S. Virgin Islands are located within the Caribbean hurricane belt, and have sustained a number of major natural disasters in the past. The Virgin Islands are typically not the hardest hit islands in the region, but when a disaster does occur they often suffer major economic damage.

3.2.1 Small Island Developing States Call to Action

Over the last decade, there have been a number of governmental programs established, to assess the sustainable development of small islands. Through these programs, susceptibility to natural hazards has been identified as a major concern for the sustainable future of many of these islands. The first major call for action occurred in April 1994 at the United Nations Global Conference on Sustainable Development of Small Island Developing States (UNGCSIDS). This conference resulted in the adoption of the Barbados Programme of Action (BPOA). The program highlighted the unique nature of small islands and recognized the need for sustainable development practices at the national, state, and local level of small island developing states.

More recently, in September 2002, the World Summit on Sustainable Development (WSSD) reaffirmed the special case for SIDS, which was highlighted in the Johannesburg Plan of Implementation (JPOI) (UNEP, 2005). SIDS face special environmental and socio-economic challenges including: heavy dependence on their natural resource base (e.g. agriculture, tourism, fishing); susceptibility to international trade; high transportation and communication costs; vulnerability to natural disasters; small local markets; limited natural resources and high import content; and uncertainty of supply due to insularity and remoteness (Briguglio, 2003).

3.2.2 The Caribbean Region

Many Caribbean islands share these special environmental and socio-economic concerns. In the Caribbean region, there are 16 independent countries and 11 dependent territories, some of which are included in the United Nations official list of small island developing states (Table 1) (Figure 1).

Table 1: States and Dependent Territories of the Caribbean. United Nations SIDS and CARICOM Affiliations

Independent Countries	**Dependent Territories**
Antigua and Barbuda (SIDS, CARICOM)	**Dutch Overseas Departments**
1. Bahamas (SIDS, CARICOM)	1. Aruba (SIDS)
2. Barbados (SIDS, CARICOM)	2. Netherlands Antilles (SIDS)
3. Belize (CARICOM)	
4. Cuba (SIDS)	**French Overseas Departments**
5. Dominica (SIDS, CARICOM)	3. Guadeloupe
6. Dominican Republic (SIDS)	4. Martinique
7. Grenada (SIDS, CARICOM)	
8. Guyana (CARICOM)	**Territories of the United States of America**
9. Haiti (SIDS, CARICOM)	5. Puerto Rico
10. Jamaica (SIDS, CARICOM)	6. US Virgin Islands (SIDS)
11. St. Kitts and Nevis (SIDS, CARICOM)	
12. St. Lucia (SIDS, CARICOM)	**British Overseas Departments**
13. St. Vincent and the Grenadines (SIDS, CARICOM)	7. Anguilla
14. Suriname (CARICOM)	8. British Virgin Islands
15. Trinidad and Tobago (SIDS, CARICOM)	9. Cayman Islands
	10. Montserrat (CARICOM)
	11. Turks and Caicos Islands

SIDS=United Nations Small Islands Developing States
CARICOM=Caribbean Community and Common Market members
Source: UNEP, 2005

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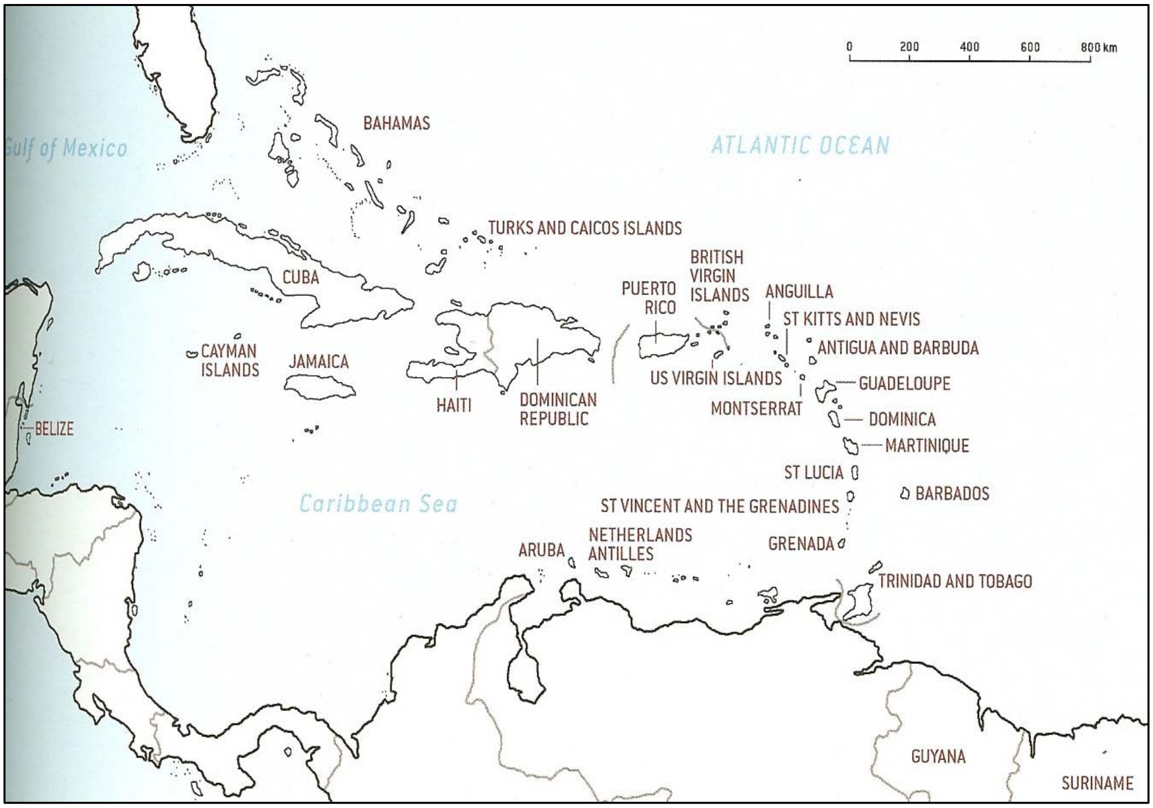

Figure 1: Map of States and Dependent Territories of the Caribbean and Their UN SIDS and CARICOM Affiliation. Source: UNEP, 2005

The national economies of the Caribbean are heavily dependent on a narrow range of natural resources for their major economic sectors of tourism, export agriculture and mineral extraction. In many of the countries, tourism equates to an average of 35 percent of Gross Domestic Product (GDP) and accounts for 20 to 86 percent of earnings as a proportion of total exports (UNEP, 2005).

Additionally, Caribbean small islands are particularly susceptible to global climate change and sea-level rise, which is further compounded by the region's economic and social vulnerability. Adding to the vulnerability of Caribbean SIDS are high levels of coastal development, high population density, variability of income, high costs of social services such as health and education, rates of population growth exceeding rates of economic growth, and large proportions of women headed households.

The Caribbean region is also prone to a number of natural disasters such as hurricanes, earthquakes, volcanic eruptions, floods, droughts, tsunamis and landslides. According to the UNEP (2005), the Latin America and Caribbean region ranked second after Asia in terms of total disaster occurrence from 1970 to 1999, experiencing 16.3 percent of the 5,970 natural disasters recorded worldwide. Over the period 1975 to 2002, more disasters have occurred and a greater number of people have been killed or affected by disasters in Latin America than in the Caribbean SIDS and low lying coastal countries (LLCS); however, the proportion of the population affected by disaster is much higher in the latter (UNEP, 2005).

Because of their small size, disaster can completely overwhelm a Caribbean nation. In a review of natural hazards in Antigua, Lewis (1984) concluded that after a disaster islands sustain the highest proportional social and economic damage compared to larger land masses. For example, in 1979, Hurricane David killed over 2,000 persons in the Dominican Republic and left over 200,000 homeless. Hurricane Gilbert caused two billion dollars in damage in Jamaica in 1988, and the following year Hurricane Hugo left three billion dollars in damage along its path from Guadeloupe through the U.S. Virgin Islands to Puerto Rico (Cross, 1992). An analysis of damage sustained in Central America and the Caribbean from Hurricane Mitch in 1998, concluded that the magnitude of sustained damage ($8.5 billion) was a direct result of an intense storm colliding with profound human vulnerability. The researchers concluded that Hurricane Mitch is “a harbinger of future disasters unless actions are taken to reduce societal vulnerability" (Pielke et. al., 2003, p.112).

The UNEP (2005) provided evidence that natural disasters appear to be increasing, which will have a greater effect on GDP in the Caribbean SIDS and LLCS. For example, natural disasters have potential to cause severe consequences for the tourism industry, with a large portion of the tourism infrastructure is located on beachfront property making it susceptible to extreme climactic events.

3.2.3 United States Virgin Islands

There is a considerable need to conduct a social vulnerability assessment in the U.S. Virgin Islands. There are numerous governmental organizations that provide funding and support for sustainable development and hazard mitigation projects in small island developing states, especially those in the Caribbean (e.g. Caribbean Development Bank, Caribbean Disaster and Emergency Response Agency, UNEP, USAID, OAS), yet none have addressed social vulnerability issues in the U.S. Virgin Islands. The bulk of research endeavors specific to Caribbean island vulnerability have assessed physical vulnerability rather than socio-economic vulnerability. With the exception of Boruff and Cutter (2007), there remains a lack of research that combines geographic theory with vulnerability assessment methodologies at different spatial scales for Caribbean islands.

The Caribbean region (often referred to as the Antilles or the West Indies), is divided into four geographical areas: The Greater Antilles; the Lesser Antilles; the South American offshore islands; and the Bahamas Group. The U.S. Virgin Islands composed of the islands of St. Croix, St. Thomas, and St. John is an unincorporated territory of the

United States, located in the northernmost portion of the Lesser Antilles in the Caribbean region (Figure 2). People born in the U.S. Virgin Islands are citizens of the United States. A territorial governor is elected every four years as well as 15 senators every two years. Additionally, the islands participate in the U.S. democracy by sending an elected, nonvoting representative to the U.S. House of Representatives.

Figure 2: Map of the Caribbean Region. The U.S. Virgin Islands of St. Croix, St. Thomas, and St. John displayed in inset map.

3.2.4 Demographic Characteristics of the U.S. Virgin Islands

Since 1970, the population in the U.S. Virgin Islands has quadrupled to approximately 120,000, although, the current growth rate is slightly less than two percent per year. It has been argued that the growth rate would be higher if not for a large number of outmigration to the mainland each year. The U.S. Virgin Islands host a large number of immigrants from other islands in the West Indies that come seeking economic opportunity, as well as U.S. mainlanders (referred to as continentals) that are often wealthy older retirees. Additionally, there are a significant number of youth from Britain, Canada, France and America that relocate to the USVI's for jobs in the tourism industry.

The racial composition of the islands stems from a long standing history in the slave trade, in that blacks outnumber whites by more than four to one; although, St. John and St. Croix both have a significant white population. People of African descent tend to have a majority in both the political and professional sectors of the islands. Additionally, one-third (more than 20,000) of the population of St. Croix claim Puerto Rican descent.

3.2.5 Economic Characteristics of the U.S. Virgin Islands

In contrast to the United States, social status is tied more to a person's level of education, profession and income rather than their racial or cultural background. However, people that are island-born or children of island-born parents (called belongers) have a special social status. Belongers hold the majority of government jobs in the US Virgin Islands. Educational attainment is similar to the United States, as the schools in the USVI's follow the same system of education as the United States.

The U.S. Virgin Islands economy is dominated by tourism. The islands host more than two million visitors per year, and the resulting revenue represents around 70 percent of the island's GDP. The USVI's also have a large manufacturing sector made up of companies that produce petroleum, pharmaceuticals, textiles, electronics and rum. The agricultural sector represents less than seven percent of the overall economy. The service industry employs approximately 62 percent of the workforce and the largest employer in the islands is the territorial government. Per capita income in the U.S. Virgin Islands is among the highest in the Caribbean at about 13,000 dollars per year (Lonely Planet, 2001).

3.2.6 Physical Characteristics of the U.S. Virgin Islands

The U.S. Virgin Islands are comprised of the three hilly islands of St Croix (80 sq. miles), St. Thomas (30 sq. miles) and St. John (19 sq. miles). The islands were formed from a series of volcanic events that took place along the boundary line of the North American and Caribbean tectonic plates. The islands are composed of three geographical zones: the coastal plain, coastal dry forests and the central mountains. All three islands have a ridge of mountains with an elevation around 1000 feet or more running from west to east across their interior.

Because of their proximity to the boundary of the Caribbean tectonic plate, these islands are susceptible to earthquakes. Furthermore, the region is inclined to drought, flooding and landslides. The Islands also lie in the heart of hurricane alley and experience at least one tropical storm a year. The U.S. Virgin Islands have suffered devastation from three major hurricanes in the last two decades- Hurricane Hugo in 1989, and both Hurricanes Luis and Marilyn in 1995. They also experienced a direct hit from Hurricane Lenny in November 1999.

According to UNEP (2005), of all the disasters that occurred from 1990 to 1999, the U.S. Virgin Islands only experienced 11 fatalities. However, from the disasters occurring in that same time period the economic losses endured (in thousands) were $1,531,500. The total economic losses suffered in the Caribbean region from 1990 to 1999 were $3,793,574. That means that forty percent of all economic losses endured from natural disasters in the Caribbean from 1990 to 1999 resulted from the two storms that directly affected the U.S. Virgin Islands.

3.3 Research Objectives

Understanding social vulnerability within the U.S. Virgin Islands is essential for quality public policy practices to be adopted for preparing for, mitigating and responding to natural hazard events. The primary objectives of this research are to:

1. Test the applicability of the Social Vulnerability Index methodology within the United States Virgin Islands. Can an index of vulnerability created for the United States be applied in a Caribbean island setting? What variables are appropriate for assessing the social fabric of the Virgin Islands?

It is expected that the Social Vulnerability Index will be useful for assessing vulnerability within an island context, but it is also anticipated that several adjustments to the choice of input variables will be needed to increase the accuracy of measurement of social vulnerability. The process of measurement should remain the same, yet the indicators used to describe vulnerability should differ as the racial, ethnic and economic composition of the islands is different from that of the United States.

2. Conduct a comparative analysis of social vulnerability between and within the islands of St. Croix, St. John and St. Thomas. Will the Social Vulnerability Index allow for an accurate comparison of social vulnerability between and within these islands? Which of the three islands will be the most vulnerable, and why? Which subdistricts within each island will be the most vulnerable, and why?

It is expected that St. Croix will be the most vulnerable of the three islands in the U.S. Virgin Islands. St. Croix contains two of the three major urban areas in the U.S. Virgin Islands (Christiansted and Frederiksted). Typically, large urban centers are highly diverse in terms of their social and economic compositions. Additionally, density of the built environment is a major factor contributing toward vulnerability to natural hazards, and with two densely population and highly built up towns, St. Croix should be the most vulnerable island. Based on the same logic, it is also expected that St. John will be the least vulnerable of the three islands. St. John is considered to be the most affluent of the U.S. Virgin Islands, and two-thirds of the island is protected from development by the National Parks Service.

It is expected that subdistricts with diverse cultural and ethnic populations will be among the most vulnerable. Those that have high percentages of Hispanics, Asians, other races, foreign born and persons speaking English less than "very well" will have higher vulnerability scores. It is also expected that more affluent communities will be less vulnerable than less affluent communities. Additionally, it is expected that the racial and ethnic composition of the islands will reflect the same geographic patterns as the wealth of the communities. For instance, the more diverse the community the less affluent it is expected to be. Another expectation is that cost of living (e.g. median rent and median dollar value of homes) will reflect the wealth of the individuals or households in the community in that the wealthier the population, the greater the cost of living. A higher economic status is expected to decrease vulnerability, yet the wealth of a community may also predict higher levels of vulnerability in that there is more to lose in a disaster event. Finally, it is expected that subdistricts with higher populations of children and higher populations of elderly will be more vulnerable. Accordingly, it is expected that Christiansted and Frederiksted in St. Croix and Charlotte Amalie in St. Thomas will be the most vulnerable subdistricts in the U.S. Virgin Islands.

3.4 Analysis

A social vulnerability assessment was conducted for the United States Virgin Islands using subdistrict level data obtained from the 2000 U.S.Census. The U.S. Virgin Islands are administratively divided into the three districts of St. Croix, St. John and St. Thomas, which are further subdivided into subdistricts (Table 2) (Figure 3). The subdistrict enumeration unit was chosen for its potential ability to show variation in vulnerability within and between each of the islands. This was the smallest unit of analysis with ample available data.

Table 2: United States Virgin Islands Administrative Divisions

St. Croix	**St. John**	**St. Thomas**
1. Anna’s Hope Village	1. Central	1. Charlotte Amalie
2. Christiansted	2. Coral Bay	2. East End
3. East End	3. Cruz Bay	3. Northside
4. Frederiksted	4. East End	4. Southside
5. Northcentral		5. Tutu
6. Northwest		6. Water Island
7. Sion Farm		7. West End
8. Southcentral		
9. Southwest		

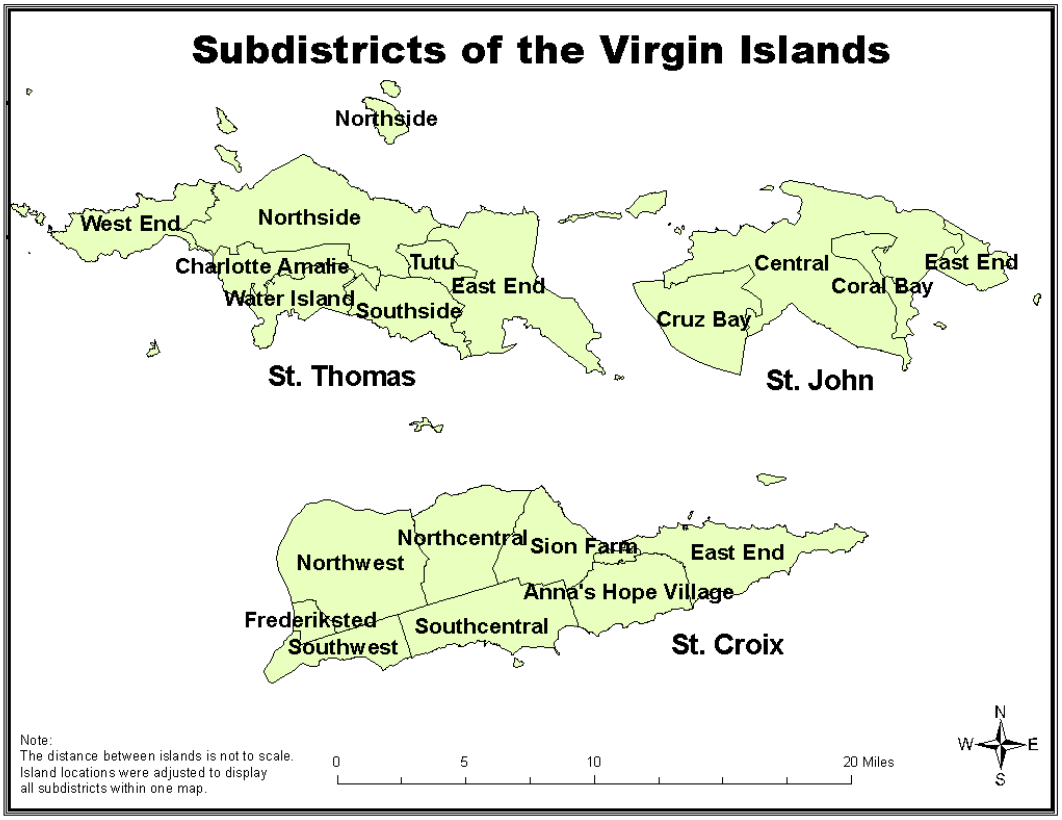

Figure 3: Administrative subdistricts within the islands of St. Croix, St. John and St. Thomas, United States Virgin Islands.

3.4.1 Data Collection

Data were obtained from several sources: the United States Census Bureau 2000 Population and Housing Profile for Island Areas; the 2000 U.S. Census International Database; the 2002 Census of Agriculture for the Virgin Islands; and the 2002 Economic Census of Islands Areas. Additionally, the Virgin Islands Health Directory (www.vihealthdirectory.com) was used to compile a comprehensive list of hospitals and physicians and their locations within the islands. This is the only comprehensive listing of all health resources in the U.S. Virgin Islands. An email was sent to the database administrator of the Virgin Islands Health Directory to confirm the accuracy of the data. It was determined that the website is updated constantly, and most new arrivals to the island contact the website to request a listing. Additionally, every listing is contacted on a yearly basis to make sure they are still conducting business on the island.

Thirty five of the original 42 variables included in the SoVI algorithm (Cutter, Boruff & Shirley, 2003) were available at the subdistrict level for each of the islands (percent of the population disabled was added to the analysis). Listed in the table below are the 36 variables used in this study to measure social vulnerability in the U.S. Virgin Islands at the subdistrict level with their abbreviation code for the Principle Components Analysis and the source (Table 3).

Table 3: Social Vulnerability Variables Obtained for Analysis

Variable Name	**Abbreviation code for PCA**	**Source**
1. Median Age	M_AGE	U.S. Census Population and Housing Profile for Island Areas, 2000
2. Per Capita Income	PCINC	U.S. Census Population and Housing Profile for Island Areas, 2000
3. Median Dollar Value Owner Occupied Housing	MEDOWN	U.S. Census Population and Housing Profile for Island Areas, 2000
4. Median Rent ($) for Renter-occupied Housing	MEDRENT	U.S. Census Population and Housing Profile for Island Areas, 2000
5. Number of Physicians per 1,000 Population	PHYS	Virgin Islands Health Directory (www.vihealthdirectory.com)
6. Birth Rate (number of births per 1,000 population)	BIRTH	2000 U.S. Census International Database
7. Net International Migration	N_MIGRA	2000 U.S. Census International Database
8. Percent African American	PER_AA	U.S. Census Population and Housing Profile for Island Areas, 2000
9. Percent Native American	PER_NA	U.S. Census Population and Housing Profile for Island Areas, 2000
10. Percent Asian	PER_AS	U.S. Census Population and Housing Profile for Island Areas,

		2000
11. Percent Hispanic	PER_HIS	U.S. Census Population and Housing Profile for Island Areas, 2000
12. Percent Other Races (includes American Indian, Alaskan Native, Asian, Native Hawaiian, other Pacific Islander, and some other race populations)	PER_OT	U.S. Census Population and Housing Profile for Island Areas, 2000
13. Percent of Population Under 5 Years Old	LESSFIVE	U.S. Census Population and Housing Profile for Island Areas, 2000
14. Percent of Population Over 65 Years Old	OVER	U.S. Census Population and Housing Profile for Island Areas, 2000
15. Percent of Civilian Labor Force Unemployed	UNEMP	U.S. Census Population and Housing Profile for Island Areas, 2000
16. Average Number of Persons Per Household	NUM_HH	U.S. Census Population and Housing Profile for Island Areas, 2000
17. Percent of Households Earning More Than $75,000	EARN_MR	U.S. Census Population and Housing Profile for Island Areas, 2000
18. Percent Living In Poverty	PER_POV	U.S. Census Population and Housing Profile for Island Areas, 2000
19. Percent Renter-Occupied Housing Units	RENT_OC	U.S. Census Population and Housing Profile for Island Areas, 2000
20. Percent Rural Farm Population	RURAL	U.S. Census Population and Housing Profile for Island Areas, 2000
21. Percent Housing Units that are Mobile Homes	MOBILE	U.S. Census Population and Housing Profile for Island Areas, 2000
22. Percent Population 25 Years or Older, with No High School Diploma	NO_DIPLO	U.S. Census Population and Housing Profile for Island Areas, 2000
23. Number of Housing Units Per Square Mile	HU_SQMI	*Derived from U.S. Census Population and Housing Profile for Island Areas, 2000
24. Percent of Population Participating in Labor Force	LABOR	U.S. Census Population and Housing Profile for Island Areas, 2000
25. Percent Females in Civilian Labor Force	FE_LAB	U.S. Census Population and Housing Profile for Island Areas, 2000
26. Percent Employed in Primary Extractive Industries	EMP_EXT	U.S. Census Population and Housing Profile for Island Areas,

(farming, fishing, mining, forestry)		2000
27. Percent Employed in Transportation, Communications, and Other Public Utilities	EMP_TRAN	U.S. Census Population and Housing Profile for Island Areas, 2000
28. Percent Employed in Service Occupations	EMP_SERV	U.S. Census Population and Housing Profile for Island Areas, 2000
29. Per Capita Residents in Nursing Homes	NURS	U.S. Census Population and Housing Profile for Island Areas, 2000
30. Percent of Population Disabled	DISABL	U.S. Census Population and Housing Profile for Island Areas, 2000
31. Per Capita Number of Community Hospitals	HOSP	Virgin Islands Health Directory (www.vihealthdirectory.com)
32. Percent Population Change (1990-2000)	POPCHA	2000 U.S. Census International Database
33. Percent Urban Population	URBAN	U.S. Census Population and Housing Profile for Island Areas, 2000
34. Percent Females	FEMALE	U.S. Census Population and Housing Profile for Island Areas, 2000
35. Percent Female-Headed Households, No Spouse Present	FEMHEAD	U.S. Census Population and Housing Profile for Island Areas, 2000
36. Percent Households Receiving Social Security	SOCSEC	U.S. Census Population and Housing Profile for Island Areas, 2000

It should be noted that of the remaining seven variables that were unavailable at the census subdistrict level, six were available at the island level (county equivalent for St. Croix, St. John and St. Thomas). Land in farms as percent of total, number of manufacturing establishments per square mile, earnings in thousands in all industries per square mile, number of commercial establishments per square mile, and value of all property and farm products sold per square mile were gathered from the 2002 Census of Agriculture for the Virgin Islands and the 2002 Economic Census of Islands Areas. Data were gathered on number of new residential construction permits per square mile by contacting the USVI Department of Planning and Natural Resources Division of Building Permits. The data were also only available at the island level. Although these data were not included in the analysis, they were still used as background information when assessing the overall big picture of vulnerability between the islands.

Although the Social Vulnerability Index is a valuable tool for measuring social vulnerability within a community, it should be necessary to adjust the original input variables so that they more accurately reflected the social fabric of the study area (Table 4).

Boruff and Cutter (2007) found that several preparedness indicators significantly influenced social vulnerability in the islands of Barbados and St. Vincent. These variables included: percent of housing units possessing radios and televisions, percent of housing units cooking with electricity and lighting with electricity (all thought to decrease vulnerability); and percent of housing units cooking with gas or kerosene (thought to increase vulnerability). They also found that the percentage of children attending primary school significantly impacted vulnerability in this study area.

The variables added to this study to reflect preparedness in the U.S. Virgin Islands were as follows: percent of homes cooking with electricity, percent of homes cooking with some form of alternative fuel (including gas, fuel oil or kerosene, wood or charcoal and some other methods), percent of homes with no telephone service, percent of homes not owning a vehicle, and percent of homes not receiving public water (using cisterns, tanks or drums, or other sources). Percent of children enrolled in primary school was also added (includes nursery school, preschool, kindergarten and elementary school-grades 1-8) as a reflection of Boruff and Cutter's (2007) findings.

Vulnerability indicators used to represent race and culture in the SoVI methodology, did not accurately reflect the social fabric of the U.S. Virgin Islands. According to Roopnarine (2010), the United States Virgin Islands is a plural society, meaning that there are various ethnic groups living together within the same geographic boundaries that only intermix when necessary (i.e. in the workplace). Each group holds on to its own institutional practices, systems of beliefs, values, norms, positions and roles that develop and revolve around family, religion, education and the economy (p.792). Living within the Virgin Islands are a variety of races and religions including "…blacks, browns, whites, yellows and various mixes…Christians, Muslims, Hindus, Buddhists, Jews, Rastafarians, Obeah, Shango and Voodoo" (p.793).

The variables that were added to better reflect the racial and cultural composition of the Virgin Islands were: percent foreign born population, percent of the population with no citizenship, percent of the foreign born population born on some other Caribbean island, and percent of the population speaking a language at home other than English and speaking English "less than very well."

Several other socio-economic variables were analyzed that were not previously considered in other research. Percent of households receiving public assistance was added as an additional measure of poverty within the community. Percent of housing units that are used for seasonal, recreational or occasional use only was added as an additional variable representing the tourism economy. The SoVI methodology presents number of mobile homes as an indicator of vulnerability within the community. There were an insignificant number of mobile homes within the U.S. Virgin Islands, so it was thought that percent of housing units that are Boats, RVs, vans etc. would be a better representation of housing structures heavily impacted by natural disasters. Finally, percent of homes built prior to 1989 was added to the study. After Hurricane Hugo in 1989, FEMA and the government of the Virgin Islands upgraded building codes and building practices as well as boosted the power grid. A new building code was written and implemented that required anchoring systems, hurricane clips, shutters and other hurricane resistant measures. Additionally, the power system was decentralized and fuel sources were diversified. Thus, homes built before 1989 are much more susceptible to damage than those built after that date. It is acknowledged though that structures built before 1989 may have added improvements such as hurricane resistant measures.

Table 4: Additional Social Vulnerability Variables. Derived from the 2000, U.S. Census of Island Areas

Variable Name	Abbreviation code for PCA
Percent of Homes Cooking with Electricity	ELEC
Percent of Homes Cooking with Alternative Methods (gas, fuel oil or kerosene, wood or charcoal and other methods)	COOKALT
Percent of Homes with no Telephone Service	NOTELE
Percent of Homes Not Owning a Vehicle	NOCAR
Percent of Homes Not Receiving Public Water (using cisterns, tanks or drums, or other sources)	NOWATER
Percent Enrolled in Primary School	PRIM
Percent Foreign Born	FOREIGN
Percent With No Citizenship	NOCIT
Percent of the Foreign Born Population Born in the Caribbean	CARIB
Percent Speaking a Language at Home Other Than English,	NOENG

Speak English Less Than "very well"	
Percent of Households Receiving Public Assistance	PUBASSIST
Percent of Housing Units Used for Seasonal, Recreational or Occasional Use Only	RECHOME
Percent of Housing Units that are Boats, RV, Vans etc	BOATS
Percent of Homes Built Prior to 1989	YRBLT

3.4.2 Principle Components Analysis

All of the variables collected at the subdistrict level for the U.S. Virgin Islands were standardized using percentages, per capita or density (per square mile) functions. The accuracy of the data was explored using descriptive statistics and then normalized using z-scores. A Principle Components Analysis was used to identify the variability among observed variables for this study.

Principle Components Analysis (PCA) (a data reduction method of factor analysis) was used in this study to simplify the interpretation of a large multivariate dataset by identifying groups of variables that behave similarly. PCA is a data reduction methodology that identifies a smaller number of components that explain most of the variance observed in the larger dataset. The purpose of performing principle components analysis was to provide a broad explanation of the data by grouping like variables into component groups for classification and ease of further analysis. The goal is to arrive at a minimum number of components that will adequately account for the covariation among the larger number of analysis variables. Additionally, PCA helps to determine a meaningful interpretation of the component groups that provide insight into the data for use with further analysis.

The Social Vulnerability Index algorithm (Cutter, Boruff & Shirley, 2003) requires that varimax rotation and the Kaiser criterion be used for component selection with eigenvalues greater than 1.0. The varimax rotation was selected because of its tendency to load each variable highly on only one component. The resulting components were then analyzed for correlations between the variables and the component loadings given in the loading matrix output of the PCA. The component groups were named in terms of their broad representation of social vulnerability and assigned a cardinal direction, positive if the majority of variables in the component increase vulnerability, negative if the majority of variables decrease vulnerability and the absolute value if the component variables have a mixed impact on vulnerability.

To compute the Social Vulnerability Index (SoVI), component scores were generated for all subdistricts within each island. The SoVI is a relative measure of the overall social vulnerability for each subdistrict. Each component is thought to have an equal contribution to the impact of vulnerability, and thus no weights were assigned to any of the components in the equation. Cardinal directions were applied to each component (i.e. +, -, absolute value) and the components were summed for an overall score of vulnerability. The scaling of values is done so that positive values indicate higher scores where as negative values indicate lower scores of vulnerability.

The main function of this analysis was to determine the social vulnerability characteristics that were represented and if they had a tendency to increase or decrease social vulnerability. The SoVI scores were then imported into a Geographic Information System (GIS) for further analysis.

3.4.3 Comparative Assessment of Vulnerability Using GIS

First, a comparative assessment of social vulnerability between the islands of St. Croix, St. John and St. Thomas was conducted. The Social Vulnerability Index scores were computed by adding together the individual component scores for each subdistrict for an overall score for each subdistrict. The island score was then computed by averaging all of the subdistrict Social Vulnerability Index scores. Because each island had a different number of subdistricts, the mean score for each island was computed for a cross-comparison. In order to rank islands in terms of vulnerability, the mean vulnerability score for each island was mapped using ArcMap. The individual socio-economic variables of vulnerability were then examined for a more detailed understanding of the fabric of the U.S. Virgin Islands' society.

The next step was to conduct a cross-comparison between all subdistricts in the U.S. Virgin Islands to determine the overall most vulnerable and least vulnerable regions. In order to do this, the Social Vulnerability Index scores were mapped in a GIS by subdistrict for each island. The scores were then ranked from highest to lowest to determine the most vulnerable to least vulnerable subdistricts. The subdistricts with the highest and lowest Social Vulnerability Index scores were identified, along with the subdistricts that were far above and below the average Social Vulnerability Index score for the U.S. Virgin Islands (the mean Social Vulnerability Index score for the U.S. Virgin Islands was computed).

Two maps were then created to compare the Social Vulnerability Index scores for all subdistricts between the three islands of St. Croix, St. John and St. Thomas. The first map displayed the Social Vulnerability Index scores for each subdistrict in all three islands using the standard deviation classification scheme. Mapping standard deviation showed how much a feature's attribute value varies from the mean. A color ramp was chosen to highlight subdistricts with values above the mean (in red) and below the mean (in blue). In this case, the dark red values represented the areas farthest from the mean in the positive direction, indicating that they were the most highly vulnerable and the dark blue values showed the areas farthest from the mean in the negative direction, indicating that they were the least vulnerable. The color ramp (dark red to dark blue) portrayed the areas from highest to lowest vulnerability in the U.S. Virgin Islands. The second map was created to illustrate the Social Vulnerability Index values for each subdistrict in each island. The map features were classified using natural breaks, in which classes were arranged using natural groupings in the dataset. Data values were arranged in order from lowest to highest, and the class breaks were placed where there was a relatively large gap in the data values. The values in light blue and dark blue represented negative index scores, or those that had low vulnerability values and the values in light red and dark red represented positive index scores, or those that had high vulnerability values. The values in the middle class (those in yellow) were grouped around the average vulnerability value.

In order to gain a deeper understanding of social vulnerability in the U.S. Virgin Islands, a comparative analysis of vulnerability scores within each subdistrict in each of the three islands of St. Croix, St. John and St. Thomas was conducted. The Social Vulnerability Index scores were ranked from highest to lowest, to show the most vulnerable to least vulnerable subdistricts in each island. The PCA generated component scores for each of the eight component categories. The component scores can be interpreted as linear combinations of the original variables within each component category. The component scores for each of the eight component categories were then mapped to portray the spatial patterns of social vulnerability within each subdistrict. The components with a greater influence on social vulnerability were displayed in red, while the components with the least influence on social vulnerability were displayed in blue.

For subdistricts with the highest Social Vulnerability Index scores, the components with the greatest influence on vulnerability were examined. For subdistricts with the lowest Social Vulnerability Index scores, the components with the least influence on vulnerability were examined. Once the component groups with the greatest or least influence on social vulnerability by subdistrict were determined, the individual variables within each of the component groups were examined. The socio-economic data was compared between subdistricts to identify patterns of social vulnerability.

CHAPTER IV

RESULTS

4.1 Overview

The Social Vulnerability Index methodology was tested for its applicability in the United States Virgin Islands. The Index was first tested using 36 variables derived from Cutter, Boruff and Shirley (2003) that were found to contribute to social vulnerability in the United States. The Index was then computed using an additional set of 14 variables thought to contribute to Caribbean Island vulnerability, as deemed appropriate from existing literature and knowledge of the study area. The resulting social vulnerability scores were compared between the two models. Further, a comparative analysis of social vulnerability within and between the U.S. Virgin Islands was conducted by mapping the Index scores in a GIS.

4.2 Results of Research Question 1

Test the applicability of the Social Vulnerability Index methodology within the United States Virgin Islands. Can an index of vulnerability created for the United States be applied in a Caribbean island setting? Are the input variables appropriate for assessing the social fabric of the Virgin Islands, or will additional variables need to be added?

4.2.1 Testing the Social Vulnerability Index Model

The Social Vulnerability Index methodology (Cutter, Boruff & Shirley, 2003) was tested in the United States Virgin Islands. Thirty six variables thought to contribute to social vulnerability in the Virgin Islands were collected from the 2000 U.S. Census (refer to Appendix A for raw data). The data were converted to z-scores and run in a Principle Components Analysis. The correlation matrices were examined to ensure that there were some correlations greater than 0.30 between variables in the dataset (Wambach, K., 2010, March) (refer to Appendix B for Correlation Matrix). Communalities were assessed to ensure that all were either greater than or equal to 0.5, as any less should be removed from the analysis (Wambach, K., 2010, March). Of the thirty six variables, all had communalities greater than 0.5, yet there were three variables (number of mobile homes, percent of the population in nursing homes and the change in population between 1990 and 2000) that had lower communality scores (0.628, 0.730, and 0.657 respectively) (Table 5).

Table 5: Communalities of Original Socio-Economic Variables

	Initial	Extraction
Median Rent	1.000	.978
Median Age	1.000	.989
Per Capita Income	1.000	.960
$ Value Homes	1.000	.941
Physicians per 1,000	1.000	.905
Birth Rate	1.000	.864
% African American	1.000	.915
% Native American	1.000	.858
% Asian	1.000	.962
% Hispanic	1.000	.956
% Other Races	1.000	.945
% Under 5	1.000	.966
% Over 65	1.000	.951
Unemployment Rate	1.000	.967
Number Households/sq mi.	1.000	.939
Earning More than $75,000/yr	1.000	.934
% in Poverty	1.000	.950
Renter Occupied Housing	1.000	.892
% Rural	1.000	.962
Mobile Homes	1.000	.628
% with no Diploma	1.000	.978
Housing Units/sq. mi.	1.000	.932
% in Labor Force	1.000	.963
% Females in Labor Force	1.000	.989

Employed in Extractive Industries	1.000	.890
Employed in Transportation Industries	1.000	.886
Employed in Service	1.000	.963
Nursing Homes	1.000	.730
Disabled	1.000	.815
Hospitals per 1,000	1.000	.902
Population Change 1990-2000	1.000	.657
% Urban	1.000	.962
% Female	1.000	.951
Female-Headed Households	1.000	.947
% Receiving Social Security	1.000	.910

Extraction Method: Principal Component Analysis.

The PCA generated eight components that explained 91.254 percent of the variance among variables in the dataset. The eight components were examined to identify only those with significant component loadings (i.e. greater than 0.5 or less than -0.5) and to look for any complex variables, those that load highly on multiple components. There were three variables that contained no significant loadings; Percent Native American, Population Change from 1990-2000 and Percent Mobile Homes. These three variables were removed from the analysis, and a subsequent PCA was performed.

In the proceeding analysis containing 33 variables thought to represent social vulnerability in the Virgin Islands, there were no communalities less than 0.810 and eight components were generated by the PCA accounting for 93.966 percent of the variance among variables in the dataset (refer to Appendix C for output table and scree plot). The component loadings were examined to categorize each of the eight components in terms of their broad representation of social vulnerability and to determine how they influence vulnerability (i.e. do they increase or decrease vulnerability) (refer to Appendix D for rotated component matrix).

The eight components were named in terms of their broad representation of social vulnerability and assigned a cardinal direction, positive if the majority of variables in the component increase vulnerability, negative if the majority of variables decrease vulnerability and the absolute value if the component variables have a mixed impact on vulnerability (Table 6).

Table 6: Original Model Components of Social Vulnerability

Component	Name	Percent Variation Explained	Dominant Variables	Component Loading Scores (with Cardinal Directions Adjusted)
1	Social Structure of the Community	48.4	Percent African American Persons Per Household Median Age Percent Under 5 Years Old Percent Rural Percent Urban	+ 0.866 +0.883 -0.879 +0.857 +0.843 +0.843
2	Economic Status	10.6	Median Rent Percent in Poverty Percent in Labor Force Percent Females in Labor Force Percent Disabled Percent Unemployed	+0.892 +0.856 -0.848 -0.810 +0.787 +0.765
3	Density of the Built Environment	9.1	Physicians Per Sq. Mi. Renter Occupied Housing Housing Units Per Sq. Mi.	-0.903 +0.738 +0.680

4	Service Sector	7.0	Percent Employed in Service Sector Community Hospitals Per 1,000 People	+0.891 -0.838
5	Aging Population and Social Dependence	6.4	Percent Over 65 Years Old Percent Households Receiving Social Security	+0.924 +0.767
6	Occupation	5.0	Percent Employed in Transportation Industry	+0.892
7	Special Needs Population	4.2	Number of People in Nursing Homes (Per 1,000)	+0.713
8	Ethnicity	3.2	Percent Asian	+0.978

To compute the Social Vulnerability Index, component scores were generated for all subdistricts within each island (refer to Appendix E for component scores). Each component was thought to have an equal contribution to the impact of vulnerability, and thus no weights were assigned to any of the components in the equation. Cardinal directions were applied to each component (i.e. +, -, absolute value) and the components were summed for an overall score of vulnerability (Table 7). The scaling of values is done so that positive values indicate higher scores whereas negative values indicate lower scores of vulnerability. The SoVI is a relative measure of the overall social vulnerability for each subdistrict.

Social Vulnerability Index = (Component 1) + ABS (Component 2) + ABS (Component 3) + ABS (Component 4) + (Component 5) + (Component 6) + (Component 7) + (Component 8)

Table 7: Social Vulnerability Index Scores Original Model	
Subdistrict Name	**Social Vulnerability Index Score**
St. Croix	
Anna's Hope Village	4.12
Christiansted	5.71
East End	5.43
Frederiksted	1.94
Northcentral	2.46
Northwest	2.46
Sion Farm	2.43
Southcentral	1.90
Southwest	2.79
St. John	
Central	0.68
Coral Bay	-1.67
Cruz Bay	5.39
East End	3.59
St. Thomas	
Charlotte Amalie	0.69
East End	0.80
Northside	5.34
Southside	2.52
Tutu	0.37
Water Island	-4.75
West End	2.08

The mean vulnerability score for all subdistricts in the U.S. Virgin Islands was 2.21. Seven of the nine subdistricts within St. Croix had higher than average vulnerability scores. Christiansted and East End were the subdistricts with the highest vulnerability scores (5.71 and 5.43, respectively) and Southcentral and Frederiksted had the lowest vulnerability scores (1.90 and 1.94, respectively). St. John had two subdistricts with lower than average vulnerability scores (Coral Bay -1.67 and Central 0.68) and two subdistricts with higher than average vulnerability scores (East End 3.59 and Cruz Bay 5.39). Of the seven subdistricts on St. Thomas, five were below the mean vulnerability score. The two subdistricts with higher than average vulnerability scores in St.Thomas were Northside and Southside (5.34 and 2.52, respectively).

Water Island in St.Thomas had the lowest vulnerability score (-4.75) and Christiansted in St. Croix had the highest vulnerability score (5.71) of all the subdistricts in the U.S. Virgin Islands. East End in St. Croix (5.43), Cruz Bay ion St. John (5.39) and Northside in St. Thomas (5.34) were all considerably above the mean vulnerability score. Coral Bay (-1.67) and Central (0.68) in St. John and Charlotte Amalie, East End and Tutu in St. Thomas (0.69, 0.80, and 0.37, respectively) had some of the lowest vulnerability scores in the U.S. Virgin Islands.

4.2.2 Adjustments to the Social Vulnerability Index Model

The Social Vulnerability Index is a valuable tool for measuring social vulnerability within a community. Yet, it was deemed necessary to adjust the input variables so that they more accurately reflected the underlying social fabric of the study area. Drawing from existing literature and knowledge of the study area the following fourteen indicator variables of vulnerability were added (Table 8) (refer to Appendix A for raw data).

Table 8: Additional Social Vulnerability Variables for Adjusted Model

Variable Name	Abbreviation code for PCA
Percent of Homes Cooking with Electricity	ELEC
Percent of Homes Cooking with Alternative Methods (gas, fuel oil or kerosene, wood or charcoal and other methods)	COOKALT
Percent of Homes with no Telephone Service	NOTELE
Percent of Homes Not Owning	NOCAR

a Vehicle	
Percent of Homes Not Receiving Public Water (using cisterns, tanks or drums, or other sources)	NOWATER
Percent Enrolled in Primary School	PRIM
Percent Foreign Born	FOREIGN
Percent With No Citizenship	NOCIT
Percent of the Foreign Born Population Born in the Caribbean	CARIB
Percent Speaking a Language at Home Other Than English, Speak English Less Than "very well"	NOENG
Percent of Households Receiving Public Assistance	PUBASSIST
Percent of Housing Units Used for Seasonal, Recreational or Occasional Use Only	RECHOME
Percent of Housing Units that are Boats, RV, Vans etc	BOATS
Percent of Homes Built Prior to 1989	YRBLT

The additional input variables were converted into z-scores and combined with the original 33 variables and then run in a PCA. The correlation matrices were examined to ensure that there were some correlations greater than 0.30 between variables in the dataset (refer to Appendix B for correlation matrix). Communalities were assessed to ensure that all were either greater than or equal to 0.5, as any less should be removed from the analysis. All of the 47 variables had communalities greater than 0.70 (Table 9).

Table 9: Communalities of Adjusted Socio-Economic Variables

	Initial	Extraction
Primary School Enrollment	1.000	.962
Cooking with Electric	1.000	.946
Cooking with Alternative Fuels	1.000	.940
No Telephone Service	1.000	.809
No Vehicle	1.000	.971
Not Receiving Public Water	1.000	.938
Foreign Born	1.000	.913
No Citizenship	1.000	.932
Foreign Born from another Caribbean Island	1.000	.928
Speaking English less than "very well"	1.000	.938
Public Assistance	1.000	.953
Vacation Homes	1.000	.825
Boats	1.000	.980
Homes Built Prior to 1989	1.000	.873
Median Age	1.000	.984
Per Capita Income	1.000	.967
$ Value Homes	1.000	.922
Median Rent	1.000	.965
Physicians Per 1,000	1.000	.866
Birth Rate	1.000	.889
% African American	1.000	.939
% Asian	1.000	.892
% Hispanic	1.000	.960
% Other Races	1.000	.933
% Less than 5	1.000	.959
% Over 65	1.000	.943
Unemployment Rate	1.000	.968
Number Households Per Square Mile	1.000	.951
Earning More than $75,000/yr	1.000	.952
% Poverty	1.000	.971
Renter Occupied Housing	1.000	.936
% Rural	1.000	.931
No Diploma	1.000	.982
Housing Units/sq. mi.	1.000	.925
% in Labor Force	1.000	.975
% Females in Labor Force	1.000	.987
Employed in Extractive Industries	1.000	.906
Employed in Transportation Industries	1.000	.756
Employed in Service Industries	1.000	.948

Nursing Homes	1.000	.740
Disabled	1.000	.774
Hospitals/1,000	1.000	.936
% Urban	1.000	.931
% Females	1.000	.978
Female Headed Households	1.000	.957
% Receiving Social Security	1.000	.915

Extraction Method: Principal Component Analysis.

The PCA generated eight components that explained 92.488 percent of the variance among variables in the dataset. The eight components were examined to identify only those with significant component loadings (i.e. greater than 0.5 or less than -0.5) and to look for any complex variables, those that load highly on multiple components. There were two variables that contained no significant loadings; percent of homes with no telephone service and percent of the population in nursing homes. These two variables were removed from the analysis, and a subsequent PCA was performed.

In the proceeding analysis containing 45 variables thought to represent social vulnerability in the Virgin Islands, there were no communalities less than 0.770 and eight components were generated by the PCA accounting for 93.419 percent of the variance among variables in the dataset (refer to Appendix C for output table and scree plot). The component loadings were examined to categorize each of the eight components in terms of their broad representation of social vulnerability and to determine how they influence vulnerability (i.e. do they increase or decrease vulnerability) (refer to Appendix D for rotated component matrix).

The eight components were named in terms of their broad representation of social vulnerability and assigned a cardinal direction, positive if the majority of variables in the component increase vulnerability, negative if the majority of variables decrease vulnerability and the absolute value if the component variables have a mix of impact on vulnerability (Table 10).

Table 10: Adjusted Model Components of Social Vulnerability				
Component	**Name**	**Percent Variation Explained**	**Dominant Variables**	**Component Loading Scores (with Cardinal Directions Adjusted)**
1	Social Structure of the Community	48.288	Percent African American Persons Per Household Percent Boats, RVs, Vans Median Age Percent Foreign Born from other Caribbean island Percent Rural Percent Urban Percent Foreign Born Percent Less Than 5 Years Old Percent Attending Primary School	+ 0.876 +0.861 +0.824 -0.805 -0.802 +0.797 +0.797 +0.794 +0.771 +0.702
2	Economic Status	11.660	Median Rent Percent Households Receiving Public Assistance Percent in Poverty Percent in Labor Force Percent Females in Labor Force Percent Unemployed	+0.892 +0.883 +0.875 -0.817 -0.744 +0.741

3	Density of the Built Environment	8.124	Physicians Per Sq. Mi. Housing Units Per Sq. Mi. Renter Occupied Housing Homes Built Prior to 1989	-0.800 +0.790 +0.765 +0.713
4	Preparedness	6.699	Percent Cooking with Electricity Percent Cooking with Alternative Methods Community Hospitals Per 1,000 People	-0.917 +0.911 -0.814
5	Culture	6.318	Percent Other Races Percent Hispanic Percent Speaking English Less Than “very well”	+0.798 +0.756 +0.693
6	Aging Population and Social Dependence	4.699	Percent Over 65 Years Old Percent Households Receiving Social Security	+0.929 +0.772
7	Occupation	4.235	Percent Employed in Transportation Industry Percent Employed in Primary Extractive Industry	+0.892 +0.640
8	Ethnicity	3.396	Percent Asian	+0.921

The Social Vulnerability Index was again computed using component scores for all subdistricts within each island with each component having an equal contribution to the impact of vulnerability (i.e. no weights) (refer to Appendix E for component scores). Cardinal directions were applied to each component (i.e. +, -, absolute value) and the components were summed for an overall score of vulnerability (Table 11). The scaling of values is done so that positive values indicate higher scores whereas negative values indicate lower scores of vulnerability.

Social Vulnerability Index = (Component 1) + ABS (Component 2) + (Component 3) + ABS (Component 4) + (Component 5) + (Component 6) + (Component 7) + (Component 8)

Table 11: Social Vulnerability Index Scores Adjusted Model	
Subdistrict Name	**Social Vulnerability Index Score**
St. Croix	
Anna's Hope Village	1.95
Christiansted	6.16
East End	4.18
Frederiksted	1.84
Northcentral	1.04
Northwest	1.57
Sion Farm	2.00
Southcentral	0.30
Southwest	1.54
St. John	
Central	0.51
Coral Bay	-2.66
Cruz Bay	3.93
East End	2.16
St. Thomas	
Charlotte Amalie	2.27
East End	1.50
Northside	4.21
Southside	3.32
Tutu	-0.05
Water Island	-4.58
West End	0.39

The mean vulnerability score for all subdistricts in the U.S. Virgin Islands was 1.58. Five of the nine subdistricts within St. Croix had higher than average vulnerability scores. Christiansted and East End were the subdistricts with the highest vulnerability scores (6.16 and 4.18, respectively) and Southcentral and Northcentral had the lowest vulnerability scores (0.30 and 1.04, respectively). St. John had two subdistricts with lower than average vulnerability scores (Coral Bay -2.66 and Central 0.51) and two subdistricts with higher than average vulnerability scores (East End 2.16 and Cruz Bay 3.93). Of the seven subdistricts in St. Thomas, four were below the mean vulnerability score. The three subdistricts with higher than average vulnerability scores in St.Thomas were Northside, Southside and Charlotte Amalie (4.21, 3.32, and 2.27 respectively).

Water Island in St.Thomas had the lowest vulnerability score (-4.58) and Christiansted in St. Croix had the highest vulnerability score (6.16) of all the subdistricts in the U.S. Virgin Islands. East End in St. Croix (4.18), Cruz Bay in St. John (3.93) and Northside and Southside in St. Thomas (4.21 and 3.32) were all considerably above the mean vulnerability score. Coral Bay (-2.66) and Central (0.51) in St. John, Southcentral in St. Croix and Tutu and West End in St. Thomas (-0.05 and 0.39) had some of the lowest vulnerability scores in the U.S. Virgin Islands.

4.2.3 Differences in SoVI Scores between the Original and Adjusted Models

There were several noticeable changes in results of the Social Vulnerability Index scores from the original dataset to the adjusted dataset. The most significant change occurred in the subdistrict of Charlotte Amalie in St. Thomas. In the original dataset, Charlotte Amalie was well below the mean vulnerability score (0.69, average 2.21) whereas when the additional variables were added to the new dataset Charlotte Amalie scored above average (2.27, average 1.58).

The majority of the differences between Index scores in the original and adjusted models occurred in the island of St. Croix. The three subdistricts of Northcentral, Northwest and Southwest had higher than average vulnerability scores in the original model (2.46, 2.46 and 2.79, respectively), but lower than average and average scores in the adjusted model (1.04, 1.57 and 1.54, respectively). Southcentral went from slightly lower than average (1.90, average 2.21) in the original model to significantly below average (0.30, average 1.58) in the adjusted model. Anna's Hope Village in St. Croix scored above average in both models, but the difference between the scores was notable (4.12 in the original, 1.95 in the adjusted).

Also of note were differences in subdistrict SoVI scores in the island of St. Thomas. In the original model, Southside was slightly above the mean (2.52, average 2.21), and in the adjusted model it was significantly higher than the mean vulnerability score (3.32, average 1.58). West End changed from just below average in the original model (2.08, average 2.21) to significantly below average in the adjusted model (0.39, average 1.58). Also, in the original model East End scored well below average (0.80, average 2.21) and in the adjusted model had an average vulnerability score (1.50, average 1.58).

The four subdistricts with the highest overall vulnerability scores for the whole of the U.S. Virgin Islands were the same in both models, but the order in which they scored was slightly different. The four subdistricts having the highest vulnerability scores in the original model were (in descending order); Christiansted and East End in St. Croix, Cruz Bay in St. John and Northside in St. Thomas. The four subdistricts scoring the highest in the adjusted model were (in descending order); Christiansted in St. Croix, Northside in St. Thomas, East End in St. Croix and Cruz Bay in St. John.

The three subdistricts having the lowest vulnerability scores were the same between both models (in ascending order; Water Island in St. Thomas, Coral Bay in St. John, and Tutu in St. Thomas). However; in the original model, the subdistrict with the fourth lowest vulnerability score was Central in St. John and in the adjusted model was Southcentral in St. Croix.

As expected, the adjusted model was found to be most appropriate for assessing social vulnerability in the U.S. Virgin Islands, and thus was used for the subsequent analyses. It was considered more appropriate as additional variables were included that more accurately reflected the social and economic fabric of these islands. In addition, it included variables that were found in previous research conducted in the Caribbean to be significant indicators of vulnerability that had not been included in the original Social Vulnerability Index Model (Cutter, Boruff and Shirley, 2003).

4.3 Results of Research Question 2

Conduct a comparative analysis of social vulnerability within and between the islands of St. Croix, St. John and St. Thomas. Will the Social Vulnerability Index allow for an accurate comparison of social vulnerability within and between these islands? Which of the three islands will be the most vulnerable, and why? Which subdistricts within each island will be the most and least vulnerable, and why?

The Social Vulnerability Index Scores were mapped in a GIS for further analysis. The component scores were imported into a GIS map document as a Microsoft Excel (.xls) table and joined to a geodatabase containing the island subdistrict polygon files. The scores for each subdistrict were displayed using standard deviations from the mean. Standard deviation was selected as the preferred mapping technique as it shows how much variation in the vulnerability scores there is from the mean vulnerability score. The individual component scores were also mapped, so as to determine which components (and their subsequent vulnerability indicators) had the most influence on the overall social vulnerability index scores.

4.3.1 Socio-Economic Structure of the Islands

St. Croix

St. Croix is the largest of the three islands with approximately 83 square miles. The terrain on the east end of the island is rocky and arid with short grassy hillsides, while the west end is lush and mountainous. The north side of the island from Christiansted west is also hilly and steep. St.Croix is the flattest of the three islands as it was formed by a coral reef rather than by volcanic activity. The middle of the island is composed mainly of rolling pastures and beaches.

Residential areas are spread out throughout the island, with a concentration of homes, schools and commercial establishments in the center of the island. There are two main towns in St. Croix, Frederiksted on the western end of the island and Christiansted on the northern coast. Most of the resorts and condominiums are found on the north shore of the island. Of the total housing units on the island in 2000, 81.8 percent were occupied and approximately half are owner-occupied (50.4%) and half are renter occupied (49.6%).

The total population of St. Croix, in 2000, was 53,234 with just over half of the population being female (52.2%). The median age was 31.9 years old. 8.4 percent of the population was 65 years old and over and 8.4 percent of the population was less than five years old. Approximately one quarter of all households were headed by a female with no husband present (26.2%) and just over half of all females were employed in the labor force (55.7%). The median income, in 2000, was 21,401 dollars, while nine percent of the population earned more than 75,000 dollars per year. Of the total population over age 25, 42.6 percent had less than a twelfth grade education (or had not earned a diploma or equivalency). The unemployment rate was 6.9 and 38.7 percent of individuals were living in poverty. Of the 19,455 total households, 8.7 percent collected public assistance income and 17.4 percent were on social security. Therefore, roughly one quarter of the population in St. Croix was receiving some form of government assistance in 2000. Additionally, 11.7 percent of households in 2000 received retirement income.

English was the most common language spoken in St. Croix, although Spanish was spoken by the Puerto Rican and Dominican (Dominican Republic) populations and French or French Creole was spoken by the Saint Lucian and Dominican (Dominica) populations. A majority of the islanders also speak a native-English based dialect called Crucian (formally Virgin Islands Creole) in informal settings. According to the 2000 U.S. Census, 68.1 percent of the population in St. Croix only spoke English, while 31.9 percent spoke a language other than English (10.7% spoke English less than “very well”). The majority of those speaking a language other than English spoke Spanish (24.2%), followed by French or French Creole (6%).

According to the 2000 U.S. Census, 69.8 percent of the population in St. Croix was native to the island, of which 13.6 percent were born in the United States, and 6.1 percent were born in Puerto Rico or other U.S. Island Area. Of the 30.2 percent foreign born population, 92.8 percent were born in the Caribbean region. In 2000, 21.2 percent of the population in St. Croix was Hispanic or Latino. The large Puerto Rican population living in St. Croix emigrated in the 1930s, 1940s and 1950s for work in the sugar plantations. Approximately one quarter of the population of the subdistricts of Christiansted, Northcentral, Sion Farm, Southcentral and Southwest claimed Hispanic or Latino, in the 2000 Census. Much of the foreign born population from other Caribbean islands emigrated in the 1960s and 1970s for work in the tourism trade, manufacturing and oil refining industries. In 2000, almost three quarters of the total population were black (73.3%), 11.6 percent were white and 10.7 percent claimed other races (included American Indian, Alaska Native, Asian, Native Hawaiian and Other Pacific Islander).

The dominant economic activity on the island was tourism, although there were a number of other industries. One of the world's largest petroleum refineries (HOVENSA, a division of the U.S. based Hess Corporation) is located in St. Croix, in the Southcentral subdistrict. The Cruzan Rum Distillery (makers of Cruzan Rum and other liquors such as Southern Comfort) is located in Frederiksted. In 2000, 20.9 percent of the employed population in St. Croix worked in service occupations and 15.1 percent worked in construction, extraction and maintenance occupations. The largest percentage of jobs were in the educational, health and social service industry (16.9%); followed by construction (12.7%), retail trade (11.5%), arts, entertainment, recreation, accommodation and food services (11.4%) and manufacturing (11%) for a total of just over a half of all jobs in St. Croix (63.5%).

St. John

St. John Island is approximately 20 square miles of rolling hills and valleys, with few flat areas. More than two-thirds of the island is protected by the National Park Service for the U.S. Virgin Islands National Park. Much of the land on St. John is preserved, so development is heavily restricted in comparison to neighboring St. Thomas. St. John is considered to be the wealthiest and most expensive of the U.S. Virgin Islands. Most of the resorts, vacation villas and residential homes are located in and around Cruz Bay and Coral Bay. Cruz Bay is the main town and harbor in the island with most of the commercial development, but there are also a large number of businesses in the Coral Bay area. Some of the most popular beaches in the Caribbean are located along the north shore of the island in the Virgin Islands National Park. The remaining coastal land in the north and east is privately owned and contains many secluded villas and cottages.

In 2000, St. John had the smallest total population of the three islands, with only 4,197 people. The median age was 36.7 years old. Seven percent of the population was under five years of age, while 7.2 percent of the population was 65 years of age or older. Just over half of the population was female (51.2%) and 17.1 percent of households were female headed with no husband present. Three quarters of the total female population was employed in the labor force (75.2%). In 2000, the per capita income was 18,012 dollars, and 14.9 percent of the population earned more than 75,000 dollars per year. Of the total population age 25 years or older, 28.7 percent had less than a twelfth grade education (or had not earned a diploma or equivalency), and the unemployment rate was only 2.1 percent. Only 1.8 percent of households were receiving public assistance income and 12.3 percent of households received social security income. Additionally, 9.8 percent of households received retirement income.

In the 2000 Census, 57.6 percent of the total population was black, 37.8 percent was white and 2.6 percent was of some other race. Only 4.9 percent of the population was Hispanic or Latino. Three quarters of the population were native to St. John (75.5%), of which 27.4 percent were born on a different island and 37.2 percent were born in the United States. Of the foreign born population, 87.2 percent came from another Caribbean Island. A majority of the population spoke only English (81.6%), and of those speaking a language other than English, 6.5 percent spoke English less than "very well." French (and French Creole) was the second most common language spoken in St. John (8.7%) followed by Spanish (7.8%).

The main economic activities in St. John were tourism and real estate development. In 2000, 29.2 percent of the population was employed in service and 24.8 percent in sales and office occupations, accounting for just over one half of the total employed population. Arts, entertainment, recreation, accommodation and foods services accounted for 30.9 percent of all jobs in 2000, followed by construction with 12.9 percent and retail trade with 10.2 percent.

St. Thomas

St. Thomas is 32 square miles of mostly mountainous terrain, with a long ridge of hills running west to east through the center of the island with smaller ridges branching off from the center. Charlotte Amalie, the capital of the Virgin Islands, is located in St. Thomas and is the main town on the island. Approximately half of St. Thomas' population lives in Charlotte Amalie, with most of the remaining residents living in East End, West End and Northside. Water Island is a small residential island in St. Thomas with no main town or commercial establishments.

In 2000, St. Thomas had a population of 51,181 people. The median age was 34.4 years old, 7.4 percent of the population was under five years of age and 8.4 percent of the population was 65 years of age or older. Just over half of the population was female (52.4%), and of the total households about one quarter (24.4%) were headed by females with no husband present. In 2000, 65.2 percent of all females were employed in the labor force.

According to the 2000 Census, the racial and ethnic composition of the St.Thomas was 80.7 percent black, 12.6 percent white and 4 percent other races, with 7.3 percent of any race claiming Hispanic or Latino. Only 62.9 percent of the population in St. Thomas was native to the U.S. Virgin Islands, 44.5 percent of which were born in St. Thomas, 2.4 percent were born on another of the U.S. Virgin Islands, 13.5 percent were born in the United States and 2.1 percent were born in Puerto Rico or other U.S. Island Area. Of the 37.1 percent foreign born population, 91.9 percent were born in the Caribbean region. About 20 percent of the population spoke a language other than English, and of those people 6.8 percent spoke English less than “very well.” The most common secondary language was Spanish (9.8%) followed by French or French Creole (7.0%).

The unemployment rate was 4.6 percent and per capita income was 14,061 dollars. Just over one-third of the population age 25 years and older (37.4%) had less than a twelfth grade education (or had not earned a diploma or equivalency). Approximately one-quarter of the population was in poverty (27.2%), while 11.2 percent of the population earned more than 75,000 dollars in 2000. Of the total population, 15.1 percent received social security income, 4.2 percent received public assistance income and 10.8 percent received some form of retirement income.

In St. Thomas, 30.5 percent of the population was employed in sales and office occupations 22.5 percent in service occupations and 24.3 percent were employed in management, professional and related occupations representing almost three-quarters of all jobs on the island. The industries employing the highest percentages of workers were arts, entertainment, recreation accommodation and food services (17.9%), retail trade (16.2%), education, health and social services (13.1%) and public administration (11.6%), construction (8.5%) and transportation and warehousing and utilities (8.4%).

4.3.2 Comparison of Social Vulnerability between Islands

Social vulnerability between the islands of St. Croix, St. John and St. Thomas was compared. It was expected that St. Croix would be the most vulnerable and St. John would be the least vulnerable of the islands in the U.S. Virgin Islands. First, the average social vulnerability index score was calculated for the entire U.S. Virgin Islands by totaling all the subdistrict scores and dividing by the total number of subdistricts.

Sum of SoVI scores for all subdistricts (30.2) ÷ Total number of subdistricts (20) = Average Vulnerability Score for the U.S. Virgin Islands (1.51)

Then, the mean vulnerability score for each island was compared to the overall mean vulnerability score for the U.S. Virgin Islands. The islands were ranked from most vulnerable to least vulnerable. As expected. St. Croix was the found to be the most vulnerable island with a mean vulnerability score of 2.29, St. Thomas was next with a vulnerability score of 1.01, which was just below the island average, and St. John was the least vulnerable island with a mean vulnerability score of 0.99 (Figure 4).

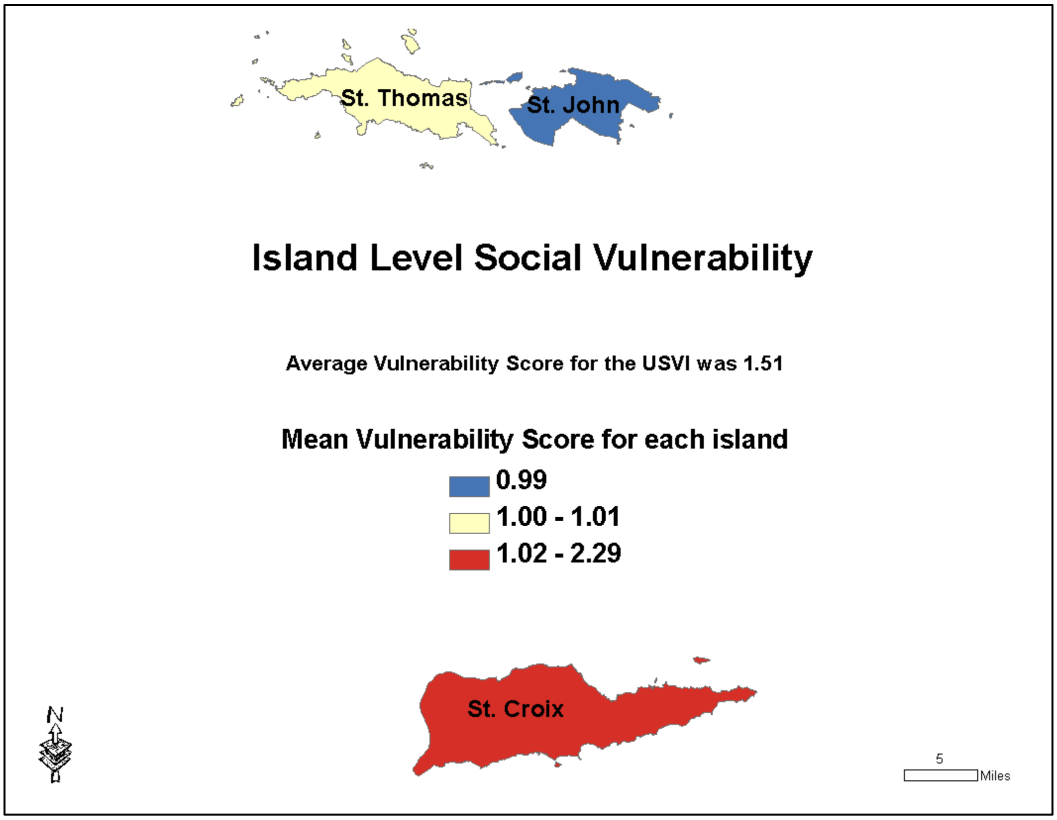

Figure 4: A Comparison of Social Vulnerability Index scores between the islands of St. Croix, St. John and St. Thomas, United States Virgin Islands.

Next, the social vulnerability index scores for all subdistricts were mapped using a standard deviation classification scheme (Figure 5). Mapping standard deviation shows how much a feature's attribute value varies from the mean. A color ramp was chosen to highlight subdistricts with values above the mean (in red) and below the mean (in blue). In this case, the dark red values represent the areas farthest from the mean in the positive direction, indicating that they are the most highly vulnerable and the dark blue values show the areas farthest from the mean in the negative direction, indicating that they are the least vulnerable. The color ramp (dark red to dark blue) portrays the areas from highest to lowest vulnerability in the U.S. Virgin Islands.

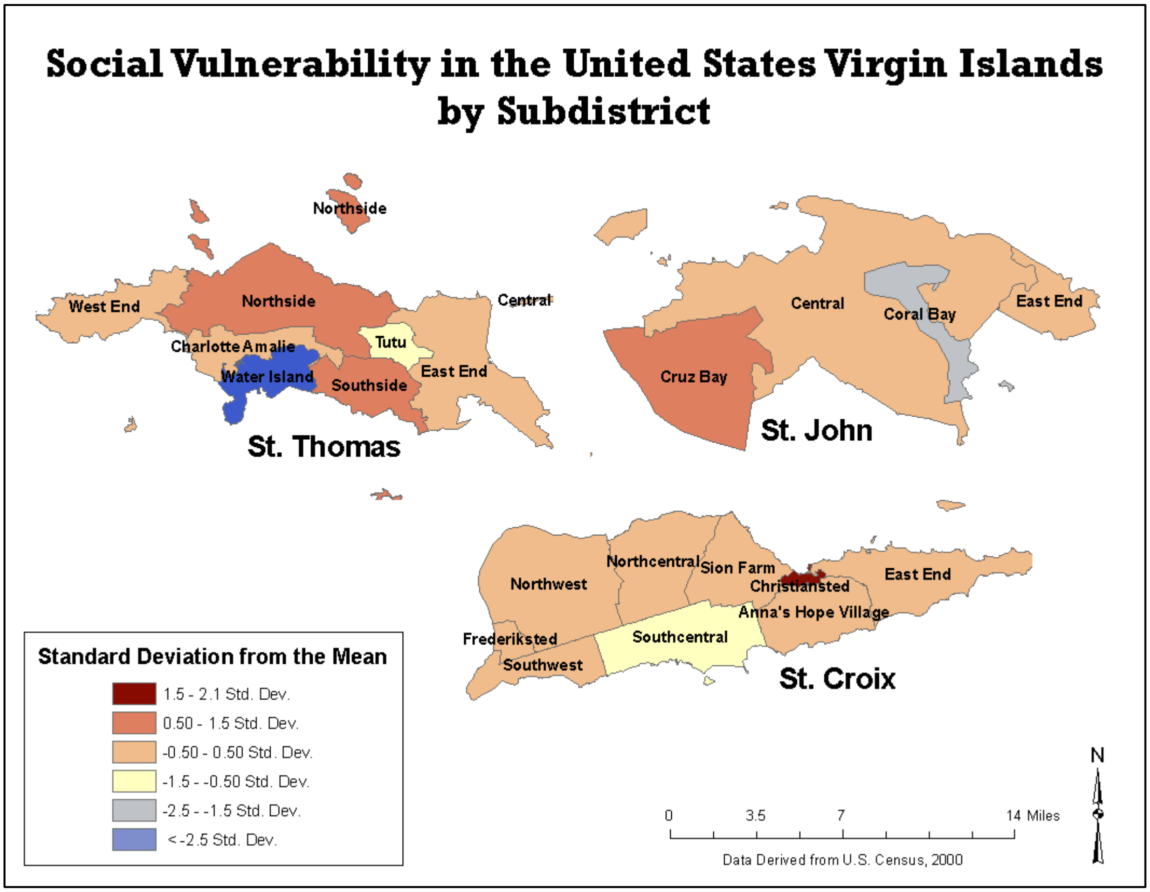

Figure 5: A Comparison of social vulnerability in the Virgin Islands by subdistrict using standard deviations from the mean.

Christiansted subdistrict in St. Croix was the farthest from the mean vulnerability score in the positive direction, indicating that it was the most highly vulnerable subdistrict in the U.S. Virgin Islands. Water Island Subdistrict in St. Thomas was the farthest from the mean vulnerability score in the negative direction, indicating that it was the least vulnerable subdistrict in the U.S. Virgin Islands. Coral Bay Subdistrict in St. John was the next lowest, followed by Tutu Subdistrict in St. Thomas and Southcentral Subdistrict in St. Croix, which both deviated least from the mean vulnerability score. Northside and Southside Subdistricts in St. Thomas and Cruz Bay Subdistrict in St. John were 0.5-1.5

standard deviations from the mean in the positive direction, indicating that they too had higher than average vulnerability scores.

An additional map was created that illustrated the actual Social Vulnerability Index values (Figure 6). The map features were classified using natural breaks, in which classes were arranged using natural groupings in the dataset. Data values were arranged in order from lowest to highest, and the class breaks were placed where there was a relatively large gap in the data values. The values in light blue and dark blue represent negative index scores, or those that had low vulnerability values and the values in light red and dark red represent positive index scores, or those that had high vulnerability values. The values in the middle class (those in yellow) were grouped around the average vulnerability value.

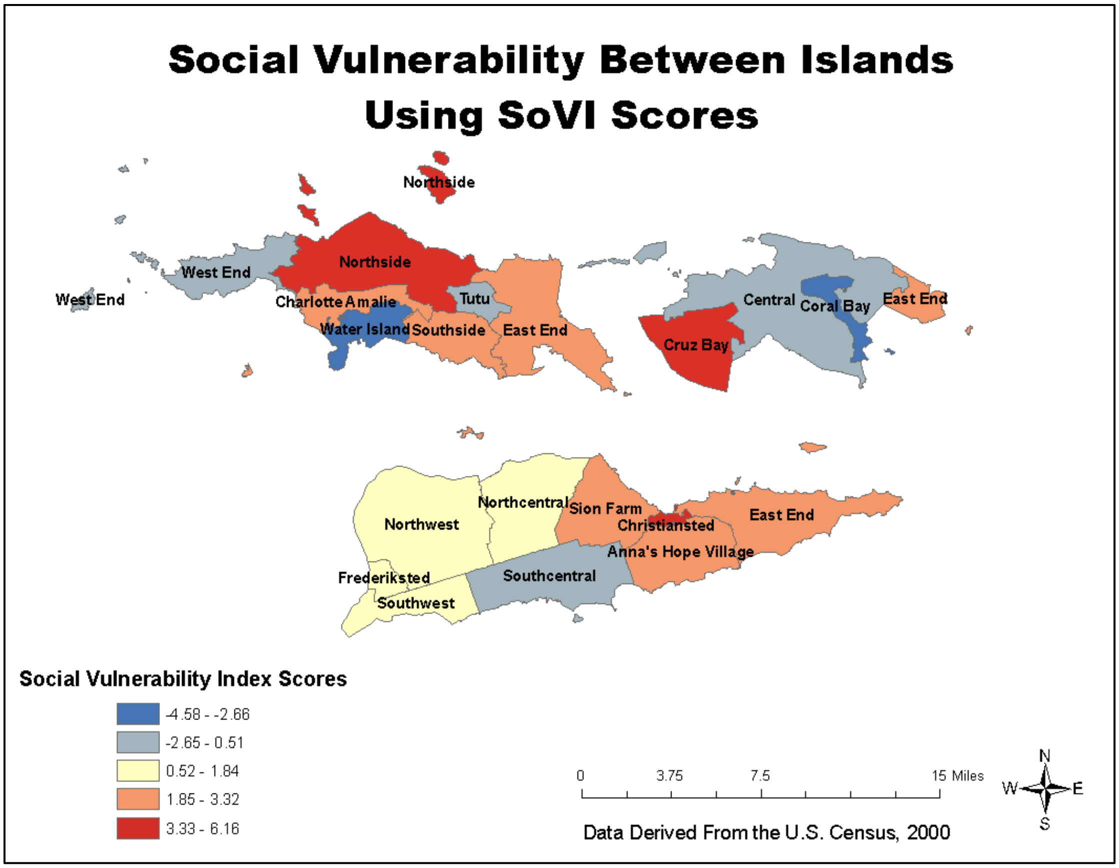

Figure 6: A Comparison of social vulnerability in the Virgin Islands by subdistrict using natural breaks.

Each island had one subdistrict in the group containing the highest Index Scores. These subdistricts included Christiansted in St. Croix, Cruz Bay in St. John and Northside in St. Thomas. The subdistricts with the lowest Index Scores were Coral Bay in St. John and Water Island in St. Thomas. The additional subdistricts that had below average vulnerability score were Southcentral in St. Croix, Central in St. John and West End and Tutu in St. Thomas. The additional subdistricts that had above average vulnerability scores were Anna's Hope Village, East End and Sion Farm in St. Croix, East End in St. John and Charlotte Amalie, East End and Southside in St. Thomas.

Using standard deviation and the natural breaks classification schemes in separate maps produced somewhat different results as far as the vulnerability groupings (i.e. highest, middle and lowest) of subdistricts, but comparing the maps side by side can still provide conclusions as to the overall picture of vulnerability in the U.S. Virgin Islands. St. Croix was the most vulnerable island of the three islands; St. Thomas was just below average and St. John was the least vulnerable island. Christiansted in St. Croix had the highest overall vulnerability score and Water Island in St. Thomas had the lowest overall vulnerability score.

The most vulnerable subdistricts in the U.S. Virgin Islands were Christiansted in St. Croix, Cruz Bay in St. John and Northside in St. Thomas. Other highly vulnerable subdistricts in the U.S. Virgin Islands included Anna's Hope Village, East End and Sion Farm in St. Croix, East End in St. John, and Charlotte Amalie, East End and Southside in St. Thomas. The least vulnerable subdistricts in the U.S. Virgin Islands were Water Island in St. Thomas and Coral Bay in St. John. Additionally, Southcentral in St. Croix, Central in St. John and Tutu and West End in St. Thomas were among the least vulnerable subdistricts.

Comparing the major socio-economic variables found to influence vulnerability in the U.S. Virgin Islands shed additional light on the major differences between the vulnerability scores of each island. All three islands had approximately the same percentage of children younger than age five and elderly adults age 65 and older. Yet, the median age was lowest in St.Croix and highest in St. John, with St. Thomas in the middle (31.9, 36.7 and 34.4, respectively). It was found that the age breakdown was consistent with the overall wealth in each island. The unemployment rate was highest in

St. Croix and lowest in St. John followed by St. Thomas (6.9%, 2.1% and 4.6%, respectively). The percentage of individuals in poverty reflects the same geographic pattern (38.7% in St. Croix, 27.2% in St. Thomas and 18.5% in St. John), as did households receiving public assistance income (8.7% in St. Croix, 4.2% in St. Thomas and 1.8% in St. John) and social security income (17.4% in St. Croix, 15.1% in St. Thomas and 12.3% in St. John). Additionally, the percentage of households earning above 75,000 dollars per year was highest in St. John (14.9%), followed by St. Thomas (11.2%) and lowest in St. Croix (9.0%). Consistently still, per capita income was highest in St. John ($18,012), followed by St. Thomas ($14,061) and lowest in St. Croix ($11,868).

Cost of housing followed similar patterns to wealth of the communities. The median dollar value of owner-occupied housing and median gross rent was highest in St. John ($246,300, $685) followed by St. Thomas ($176,400, $595) and lowest in St. Croix ($129,400, $423). Yet density of the built environment had a different pattern. Population density was greatest in St. Thomas (1,638.3 persons per square mile) compared with St. Croix (642.3 persons per square mile) and St. John (214 persons per square mile) as was housing density (769.2 households per square mile in St. Thomas, 286.9 in St. Croix and 121.9 in St. John). It was expected that the percentage of renters would be consistent with both the median dollar value of owner-occupied housing and the housing density statistics, but neither was the case. St. Thomas had the highest percentage of renters (58.6%) followed by St. John (52.3%) and St. Croix had the lowest percentage of renters (49.6%).

It was expected that the racial and ethnic composition of the islands would reflect the same geographic patterns as the wealth of the communities. The percentage of blacks was highest in St. Thomas (80.7%) followed by St. Croix (73.3%) and then St. John (57.6%). The percentage of whites was highest in St. John (37.8%) followed by St. Thomas (12.6%) and then St. Croix (11.6%). The percentage of other races (including American Indian, Alaska Native, Asian, Native Hawaiian and Other Pacific Islander and some other races) was highest in St.Croix (10.7%), then St. Thomas (4.0%) and lowest in St. John (2.6%).

St. Croix had the highest population percentage of Hispanic or Latino (21.2%) followed by St. Thomas (7.3%) and then St. John (4.9%). St. Croix also had the lowest percentage of people speaking only English (68.1%), followed by St. Thomas (80.9%) and then St. John (81.6%). The majority of the population speaking a language other than English also spoke Spanish (24.2% in St. Croix, 9.8% in St. Thomas, and 7.8% in St. John) or French (and French Creole) (6% in St. Croix, 7% in St. Thomas and 8.7% in St. John). St. Croix had the highest percentage of people speaking a language other than English that spoke English less than “very well” (10.7%), followed by St. Thomas (6.8%) and St. John (6.5%).

St. John had the highest percentage population of native born citizens (75.5%) followed by St. Croix (69.8%) and then St. Thomas (62.9%). St. Croix had the highest population percentage born on the island of residence (46.3%) followed by St. Thomas (44.5%) and then St. John (8.4%). The majority of native born citizens on St. John were born in the United States (37.2%) or born on St. Thomas (26.5%). Also, of the native born citizens, St. Croix had the highest percentage of those born in Puerto Rico (6.1%).

Of the 24.5 percent foreign born population in St. John, 87.2 percent were born in the Caribbean region. Of the 30.2 percent foreign born population in St. Croix, 92.8 percent were born in the Caribbean region, and of the 37.1 percent foreign born population in St.Thomas, 91.9 percent were born in the Caribbean region.

Consistent with research expectations were the high vulnerability scores for St. Croix and Christiansted Subdistrict in St. Croix and the low vulnerability score for St. John. Additionally, density of the built environment, culture and ethnicity, economic status and age demographics played a large role in defining social vulnerability in the islands. The racial and ethnic composition of the islands followed similar geographic patterns as the wealth of the communities and cost of living indicators had similar patterns to economic status. Inconsistent with the research expectations were the low vulnerability score for Frederiksted in St. Croix and the lower vulnerability score for Charlotte Amalie in St. Thomas.

4.3.3 Comparison of Social Vulnerability within Islands

In order to gain a deeper understanding of social vulnerability in the U.S. Virgin Islands, a comparative analysis of vulnerability scores within each subdistrict in each of the three islands of St. Croix, St. John and St. Thomas was conducted. The following section details those results.

It was expected that subdistricts with diverse cultural and ethnic populations would be among the most vulnerable. Those that had high percentages of Hispanics, Asians, other races, foreign born and persons speaking English less than “very well” would have higher vulnerability scores. It was also expected that more affluent communities would be less vulnerable than less affluent communities. Additionally, it was expected that the racial and ethnic composition of the islands would reflect the same geographic patterns as the wealth of the communities. For instance, the more diverse the community the less affluent it was expected to be. Another expectation was that cost of living (e.g. median rent and median dollar value of homes) would reflect the wealth of the individuals or households in the community in that the wealthier the population, the greater the cost of living. A higher economic status was expected to decrease vulnerability, yet the wealth of a community might also predict higher levels of vulnerability in that there would be more to lose in a disaster event. Finally, it was expected that subdistricts with higher populations of children and higher populations of elderly would be more vulnerable.

St. Croix

St. Croix was found to be the most vulnerable of the three islands. The mean vulnerability score for subdistricts in St. Croix was 2.29. Therefore, subdistricts with vulnerability scores higher than 2.29 were considered to be more vulnerable and subdistricts with scores lower than 2.29 were considered to be less vulnerable. The Social Vulnerability Index Scores were ranked from highest to lowest, to show the most vulnerable to least vulnerable subdistricts in the island (Table 12). The eight component scores were mapped by subdistrict to get a better understanding of the major factors that influence vulnerability in each subdistrict in St. Croix (Figure 7).

Table 12: Social Vulnerability in St. Croix.
(subdistricts listed from most vulnerable to least vulnerable)

Subdistrict Name	SoVI Score	Most Influential Vulnerability Categories
Christiansted	6.16	-Density of the Built Environment -Culture

		-Occupation -Economic Status
East End	4.18	-Preparedness -Aging Population and Social Dependence -Ethnicity
Sion Farm	2.00	-Density of the Built Environment -Preparedness -Ethnicity
Anna's Hope Village	1.95	-Social Structure of the Community -Economic Status -Culture -Aging Population and Social Dependence -Ethnicity
Frederiksted	1.84	-Economic Status -Density of the Built Environment -Occupation
Northwest	1.57	-Economic Status -Social Structure of the Community -Density of the Built Environment -Preparedness -Occupation -Ethnicity
Southwest	1.54	-Social Structure of the Community -Preparedness -Culture
Northcentral	1.04	-Social Structure of the Community -Culture
Southcentral	0.30	-Social Structure of the Community -Culture -Economic Status -Ethnicity

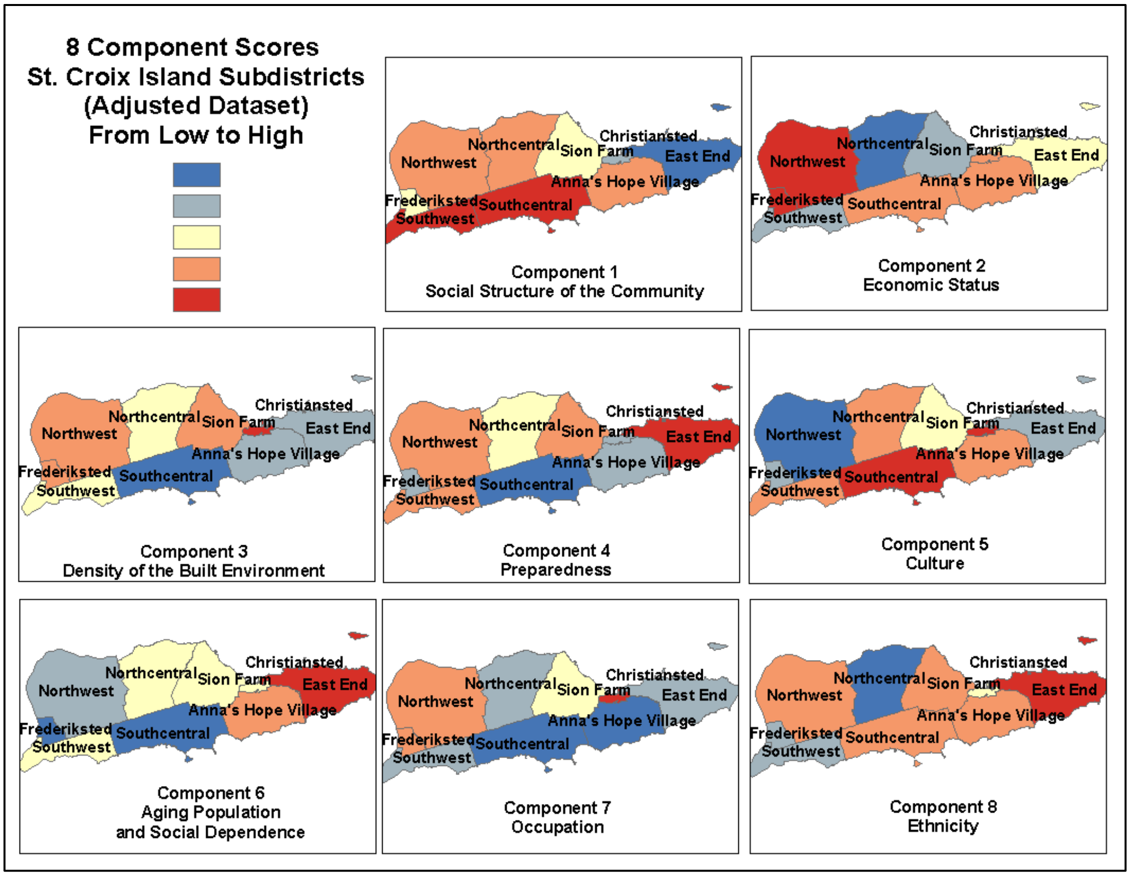

Figure 7: Component scores by subdistrict in St. Croix. Values mapped from lowest to highest.

Christiansted subdistrict was not only found to be the most vulnerable subdistrict in St. Croix, but also the most vulnerable subdistrict in the entire U.S. Virgin Islands. It had a Social Vulnerability Index Score of 6.16 far exceeding the average for St. Croix Island (2.29) and the average score for the U.S. Virgin Islands (1.51). The major components that led to this high level of vulnerability were density of the built environment, culture, occupation and economic status.

Christiansted had the highest number of housing units per square mile (2,060.8) compared with all of the subdistricts in St. Croix and the second highest in all of the U.S. Virgin Islands (besides Charlotte Amalie in St. Thomas that had 2,704.4). It also had the highest percentage of renter occupied housing units (76.6%) and the highest number of physicians per 1,000 people (18.15) of all the subdistricts in St. Croix. Additionally, Christiansted had the highest percentage of homes built before 1989 (93.7%) and the highest percentage of people not owning a vehicle (44.2%) of all the subdistricts in the U.S. Virgin Islands.

Christiansted Subdistrict had the second highest percentage of Hispanic or Latino (26.1%) and the third highest percentage of other races (15.9%). It was the Subdistrict with the highest percentage of non-citizens (18%) and had the highest percentage of people that spoke English less than “very well” (15.4%). Of the population that spoke a language other than English, the majority spoke Spanish (14.4) followed by French or French Creole (4%).

The occupational structure of Christiansted also contributed highly toward its vulnerability score. Christiansted had the highest percent of the population employed in service occupations (27%) and the second highest percentage employed in primary extractive industries (includes construction, extraction and maintenance and farming, fishing and forestry) (1.3%). The two highest employing industries were arts, entertainment, recreation, accommodation and food services (16.7%) and construction (16.3%), followed by educational, health and social services (15.2%) and retail trade (10.6%).

The economic status of the population in Christiansted Subdistrict also contributed to its high vulnerability score. Christiansted had the highest unemployment rate (9.5%) of all subdistricts in St. Croix and of all the subdistricts in the U.S. Virgin Islands. Christiansted also had among the lowest percentage of the population participating in the labor force (59.6%). Additionally, Christiansted had a large percentage of the population living in poverty (48.3%), second only to Frederiksted (56.8%). Although not the lowest on the Island, Christiansted had a low per capita income ($9,312) and had the smallest percentage of the population earning more than $75,000 per year (4.3%). Second only to Southwest, Christiansted had a large percentage of the population that was disabled (19.61).

The Social Vulnerability Index score for East End subdistrict (4.18) also far exceeded both averages and was among the highest vulnerability scores in the U.S. Virgin Islands. The components that greatly contributed to the high level of vulnerability in East End were preparedness and aging population and social dependence.

The preparedness variables greatly influenced East End's high vulnerability score. East End had the highest percentage of the population cooking with electricity (47.7%) and the lowest percentage of the population cooking with alternative fuels such as gas, fuel oil, kerosene or wood (51.6%). East End also had the lowest percentage of the population without telephone service (4.1%).

East End Subdistrict had the greatest percentage of elderly, aged 65 years and over (12.1%) of all subdistricts in St. Croix and of all subdistricts in the U.S. Virgin Islands. The median age (43.8) was also highest in St. Croix and second highest in the Virgin Islands (second only to Water Island in St. Thomas 47.9). East End also had among the highest percentage of the population collecting social security income (18%). There were only four subdistricts in the entire U.S. Virgin Islands that had a higher percentage of the population on social security, three of which were in St. Croix.

East End Subdistrict was also the most rural subdistrict in St. Croix (83.9%), and had the highest percentage of the population employed in primary extractive industries (1.7%) of all subdistricts in the U.S. Virgin Islands.

Interestingly, of all the subdistricts in St. Croix, East End Subdistrict had the lowest percentage of foreign born (18.9%), lowest percentage speaking English less than “very well” (4.8%), the lowest percentage of blacks (35.2%) and highest percentage of whites (56.6%), the lowest percentage of Hispanics (11.4%) the lowest unemployment rate (2%) and the lowest percentage of the population receiving public assistance income (0.7%), the highest median value of owner occupied housing ($214,900), and the highest median rent ($716). Additionally, of all the subdistricts in the Virgin Islands, East End Subdistrict in St. Croix had the highest per capita income ($28,490) and the highest percentage of the population earning more than $75,000 per year (28.5%). Also, of all the subdistricts in St. Croix, East End had the highest percentage of vacation homes and houseboats (16.4% and 1.2%, respectively). Looking at real estate listings in St. Croix, East End Subdistrict currently has the most expensive home on the market (listed for $2.9M in 2011). Due to the high median age and the high percentage of the population 65 years or older, the high cost of living, plus the large percentage of vacation homes, it can only be concluded that East End is an expensive retirement area for the wealthy. It received a high vulnerability score; however recovery time for a community such as this is actually much shorter than a lower income community such as Christiansted.

The subdistricts of Sion Farm, Anna’s Hope Village, Frederiksted, Northwest and Southwest all had vulnerability scores close to the Island average (2.00, 1.95, 2.84, 1.57

and 1.54, respectively). Northcentral Subdistrict (1.04) and Southcentral Subdistrict (0.30) both had the lowest vulnerability scores in St. Croix.

Northcentral Subdistrict's economic status, occupational and ethnic composition helped to lower its overall vulnerability score. The majority of the economic status variables and occupation variables for Northcentral had data values close to the median. However, Northcentral had the lowest percentage of Asian's (0.20%) in the entire U.S. Virgin Islands.

Southcentral Subdistrict had low vulnerability scores in the density of the built environment, preparedness, aging population and social dependence and occupation components. Southcentral had the least amount of homes built prior to 1989 (63.1%), or the highest percentage of newly constructed residential homes. Southcentral also had the lowest percentage of vacation homes (0.9%) and houseboats (0%). Southcentral had the lowest percentage of the population 65 years or older (6.1%), the lowest percentage collecting social security income (15.2%), and the second lowest percentage of the disabled population (16.3%). Southcentral Subdistrict had the highest percentage of the population employed in production, transportation and material moving occupations (17%) of all subdistricts in the U.S. Virgin Islands, which was inconsistent with its low vulnerability score. Manufacturing was the industry with the highest percentage of jobs (18.8%), followed by educational, health and social services (13.7%), construction (12.6%) and retail trade (12.5%).

Frederiksted Subdistrict had a median vulnerability score, although it was expected that Frederiksted would be among the most vulnerable subdistricts in the U.S. Virgin Islands. Frederiksted is the second most densely populated subdistrict in St.

Croix (second to Christiansted), with 1,181.6 housing units per square mile and 1.59 physicians per 1,000 people. Frederiksted had the highest birth rate (24.16), the highest percentage of the population less than five years old (10.8%), the lowest median age (23.7) the highest percentage of the population earning less than a twelfth grade education (52.3%), the highest percentage of female-headed households (42.1%), the lowest percentage of females employed in the labor force (51.6%), the lowest percentage of the population employed in the labor force (53.8%), the lowest per capita income ($7,696) and the highest percentage of the population receiving public assistance income (17%) in the entire U.S. Virgin Islands. Additionally, Frederiksted Subdistrict had the second highest unemployment rate (9.2%) and the second lowest percentage of the population earning more than $75,000 per year (4.4%) of all subdistricts in the U.S. Virgin Islands, second only to Christiansted Subdistrict in St. Croix.

St. John

St. John was the least vulnerable island, yet when taking a closer look within the island it is apparent that there are areas of high vulnerability and some Subdistricts are more vulnerable than others. The mean vulnerability score for the subdistricts in St. John was 0.99. Therefore, subdistricts with vulnerability scores higher than the average vulnerability score were considered to be more vulnerable and subdistricts with lower than average vulnerability scores were considered to be less vulnerable. The Social Vulnerability Index Scores were ranked from highest to lowest, to show the most vulnerable to least vulnerable subdistricts in the island. St. John is composed of the four subdistricts of Central, Coral Bay, Cruz Bay and East End (Table 13).

Table 13: Social Vulnerability in St. John. (subdistricts listed from most vulnerable to least vulnerable)		
Subdistrict Name	**SoVI Score**	**Most Influential Vulnerability Categories**
Cruz Bay	3.93	-Social Structure of the Economy -Economic Status -Density of the Built Environment -Preparedness -Culture
East End	2.16	-Aging Population and Social Dependence -Ethnicity -Economic Status
Central	0.51	-Occupation -Social Structure of the Community -Culture
Coral Bay	-2.66	-Density of the Built Environment -Preparedness -Aging Population and Social Dependence -Occupation

The two subdistricts of Cruz Bay and East End that flank the far western and eastern halves of the island were the most vulnerable, whereas the interior subdistricts of Central and Coral Bay were the least vulnerable. The individual component scores for the subdistricts in St. John were mapped in order to understand which variables had the greatest impact on vulnerability within each of the subdistricts (Figure 8).

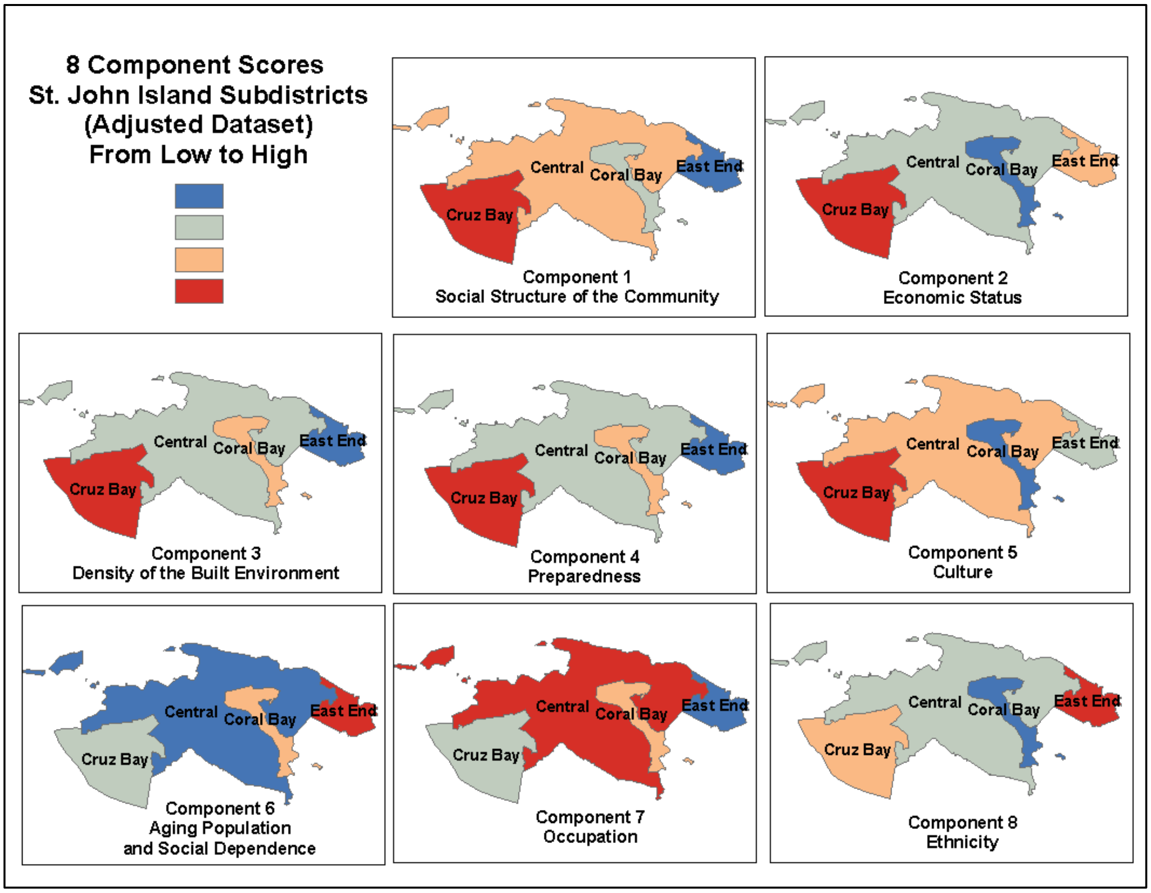

Figure 8: Component scores by subdistrict in St. John. Values mapped from lowest to highest.

Cruz Bay Subdistrict had the highest vulnerability score of all the subdistricts in St. John, with a Social Vulnerability Index score of 3.93. The components that contributed most to Cruz Bay's high level of vulnerability were social structure of the community, density of the built environment, and culture. For a more detailed understanding of the underlying causes of vulnerability in the Subdistrict, the dominant variables of each component category were examined.

Looking first at the social structure of the community, Cruz Bay had the highest percentage of blacks (65.9%) and the highest percentage of foreign born (30.8%) compared with all other subdistricts in St. John. Additionally, Cruz Bay had the highest percentage of foreign born individuals that were from another island in the Caribbean region (91.4%). Cruz Bay also had the greatest percentage of residents that were not citizens of the Virgin Islands (13.9%). The size of the household was also greatest with 2.51 persons per household. Of all the subdistricts in St. John, median age was lowest (35.3 years old), the percentage of the population less than age 5 was highest (7.8%), and the percentage of children enrolled in primary school was highest (16.5%) in Cruz Bay. According to the U.S. Census, Cruz Bay is also the only urban area on St. John. The other three subdistricts are all rural areas.

Density of the built environment also contributed to Cruz Bay's high level of vulnerability. The number of housing units per square mile was exceedingly higher in Cruz Bay compared with all other subdistricts in St. John (556 housing units per square mile). Cruz Bay also had the highest percentage of renter occupied housing units (55%) and the largest percentage of homes built prior to 1989 (74.5%). Interestingly, number of physicians per 1,000 people was included as an indicator of density of the built environment by the PCA. Cruz Bay had the highest number of physicians compared with all other subdistricts in St. John (2.92). Because Cruz Bay contains the largest city on the Island, it makes sense that the majority of practices are located there. Because of the large concentration of physicians, the vulnerability score should actually be lower. Yet, this variable is also indicative of a densely built community, which actually contributes to higher levels of vulnerability.

The cultural composition of Cruz Bay helped contribute to its high vulnerability score. Cruz Bay had the highest percentage of Hispanics or Latinos (6.8%) and also had the highest percentage of people that speak another language other than English and speak English less than “very well” (8.0%). The most common secondary language in Cruz Bay was French or French Creole (11.1% of the total population), followed by Spanish (8.7% of the total population).

East End Subdistrict had the second highest vulnerability score in St. John, with a score of 2.16. The components contributing positively to this vulnerability score were aging population and social dependence, ethnicity and economic status.

East End had the highest percentage of people age 65 years and older (11.9%) and the median age was also highest (49.5 years old). East End also had the greatest percentage of people collecting social security income (16.1%). East End also had the greatest Asian population (3.4%, compared with only 0.70 in Cruz Bay, and 0.30 in both Coral Bay and Central).

The economic status of East End also contributed to its high vulnerability score. The median rent in East End was the lowest of all four subdistricts ($525). The percentage of the population collecting public assistance income (3.2%) was highest in East End, and the percentage of the population in poverty (22%) was the second highest (highest in Coral Bay). The percentage of the population disabled was also included in this component category by the PCA. East End had the highest percent of the population disabled (17.5%). The U.S. Census of Island Areas in 2000, calculated disability income within the Social Security income category, and as noted in the previous paragraph, East End had the highest percentage of the population collecting Social Security Income (16.1%). East End had the lowest percentage of the population employed in the labor force (56.6%), but also had the lowest unemployment rate (rounds to zero). This is most likely explained by the percentage of elderly and retirees living in

East End. Although it was not included as an indicator variable, East End had the second highest percentage of the population collecting retirement income (12.9% compared with 13.8% in Coral Bay, 9.4% in Central and 8.7% in Cruz Bay).

Coral Bay and Central Subdistricts both had below average vulnerability scores, with Social Vulnerability Index scores of -2.66 and 0.51, respectively. The component groups contributing to Coral Bay's low levels of vulnerability were economic status, culture and ethnicity. The component categories contributing to Central Subdistrict's low vulnerability score were aging population and social dependence, economic status, and density of the built environment.

Coral Bay had the lowest percentage of females (49.6%) and the lowest percentage of female-headed households (10.5%). Coral Bay also had the lowest percentage of Asian population (0.3%) and the lowest percentage of other races (includes American Indian, Alaska Native, Asian, Native Hawaiian and Other Pacific Islander and some other races) (2.3%). It also had the lowest percentage of foreign born (9.9%) and the lowest percentage of the population speaking English less than "very well" (3.1%). Coral Bay also had the lowest percentage of foreign born that were from the Caribbean region (54.7%). It was expected that the higher the percentage of the population born in the Caribbean, the lower the vulnerability because of previous experience with natural disasters such as hurricanes and tropical storms. However, from the results of this study, it appears that the lower the percentage from the Caribbean region, the lower the vulnerability score. A possible conclusion that can be drawn is that persons immigrating to the Virgin Islands from less affluent Caribbean islands (e.g. Dominica, Haiti, and Jamaica) are more vulnerable and thus negatively impact the vulnerability in the U.S. Virgin Islands.

Central Subdistrict had the lowest percentage of the population age 65 and over (5.8%) and lowest percentage of the population receiving social security income (9.1%) and public assistance income (0.6%). It also had the highest per capita income ($21,051). Central had the second lowest percent of individuals in poverty (20.2%) and the second highest percentage of the population in the labor force (78.3%) (second to Cruz Bay). Central had the second highest median rent ($625) (second to Coral Bay), but the third lowest median dollar value of owner-occupied housing ($251,500). With high per capita income, low levels of public assistance, and lower property values, recovery time should be much quicker in Central Subdistrict.

Central is also a rural subdistrict with the lowest number of housing units per square mile (30.7) of all subdistricts in St. John. It also had the lowest percentage of homes built prior to 1989 (64.4%). Central also had the lowest percentage of houseboats, recreational vehicles, vans and other alternative housing (1.9%).

St. Thomas

The mean vulnerability score for the subdistricts in St. Thomas was 1.01. Therefore, subdistricts with vulnerability scores higher than the average vulnerability score were considered to be more vulnerable and subdistricts with lower than average vulnerability scores were considered to be less vulnerable. The Social Vulnerability Index Scores were ranked from highest to lowest, to show the most vulnerable to least vulnerable subdistricts in the island. Of the seven subdistricts in St. Thomas, four had above average vulnerability scores and three had below average vulnerability scores

(Table 14). The individual component scores for the subdistricts in St. Thomas were mapped in order to understand what was contributing toward the overall vulnerability score for each of the subdistricts (Figure 9).

Table 14: Social Vulnerability in St. Thomas. (subdistricts listed from most vulnerable to least vulnerable)		
Subdistrict Name	**SoVI Score**	**Most Influential Vulnerability Categories**
Northside	4.21	-Economic Status -Culture -Occupation
Southside	3.32	-Ethnicity -Social Structure of the Community -Density of the Built Environment -Culture -Occupation
Charlotte Amalie	2.27	-Density of the Built Environment -Social Structure of the Community -Aging Population and Social Dependence
East End	1.50	-Aging Population and Social Dependence -Ethnicity -Preparedness
West End	0.39	-Occupation -Social Structure of the Community -Economic Status
Tutu	-0.05	-Social Structure of the Community -Aging Population and Social Dependence
Water Island	-4.58	-Preparedness -Density of the Built Environment -Culture

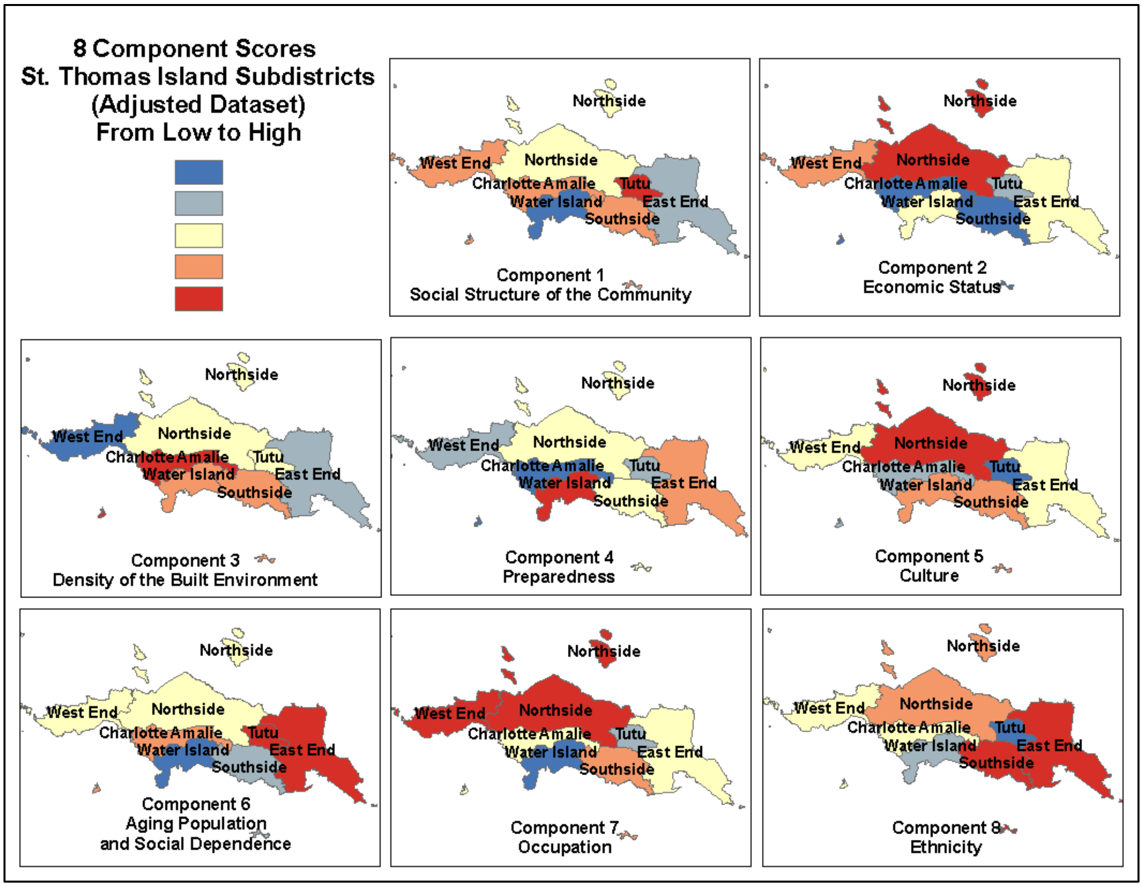

Figure 9: Component scores by subdistrict in St. Thomas. Values mapped from lowest to highest.

The subdistrict of Northside was found to be most vulnerable, with a Social Vulnerability Index Score of 4.21. The components of vulnerability having the largest impact on the overall vulnerability score for Northside were economic status, cultural composition and occupation.

The high vulnerability score of Northside Subdistrict does not make sense when looking at its economic status. Northside had the highest per capita income ($22,515) and highest percentage of the population earning more than $75,000 per year (20.7%) in St. Thomas and the second highest in the U.S. Virgin Islands (second to East End in St. Croix). Also the median dollar value of owner-occupied housing units ($231,100) and median rent ($758) was second highest in St. Thomas. The unemployment rate (2.4%) was lowest and the percentage of the population participating in the labor force (75.9%) was highest in St. Thomas.

Northside Subdistrict had the second highest percentage of other races (5.8%), the second highest percentage of Asians (2.9%) and the third highest percentage of Hispanics or Latinos (6.1%) of all the subdistricts in St. Thomas. Although, Northside had a relatively low percentage of the population speaking English less than “very well” (4.7%) and a low percentage of foreign born population (26.7%).

Northside had the highest percentage of the population employed in primary extractive industries (0.8%) in St. Thomas, although it had a low percentage employed in the service sector and transportation sector.

The second most vulnerable subdistrict in St. Thomas was Southside, with a Social Vulnerability Index score of 3.32. The most influential components of vulnerability were culture and ethnicity, social structure of the community, and density of the built environment.

Southside Subdistrict contained the highest percentage of Asian’s of all subdistricts in the U.S. Virgin Islands (4.6%). Southside also had the highest percentage of other races (7.3%) and the second highest percentage of Hispanics or Latinos (6.5%) in St. Thomas. Of the seven subdistricts in St. Thomas, Southside had the third highest percentage of the population speaking English less than “very well” (7.1%). Of the population speaking a language other than English, the largest percentage spoke French or French Creole (10.8%) followed by Spanish (9.2%). Additionally, behind Charlotte Amalie and East End, Southside had the third highest percentage of foreign born (39.3%) and non-citizens (16.8%). Of its foreign born population, Southside had 86% percent from the Caribbean region (almost one quarter of whom came from Dominica 21.3%).

Southside had the highest percentage of children enrolled in primary school (20.9%), the second lowest median age (32 years old) and second highest percentage of the population less than age five (8%) of the seven subdistricts in St. Thomas.

Southside was not as densely built as Charlotte Amalie and Tutu, yet it did have a somewhat large number of housing units per square mile (582.6) compared with many other subdistricts in the Virgin Islands. It did however, have the second highest number of persons per household (2.74) in St. Thomas, second only to Tutu (3.09), which was the highest in the U.S. Virgin Islands. Southside also had the second highest percentage of renter occupied housing units (64.9%), making it the third highest in the Virgin Islands (Christiansted in St. Croix 76.6% and Charlotte Amalie in St. Thomas 73%). Southside had the second highest number of physicians per 1,000 people (1.28) and the second highest percentage of homes built prior to 1989 (80.6%).

Charlotte Amalie was the third most vulnerable subdistrict in St. Thomas, with a Social Vulnerability Index Score of 2.27. The components of vulnerability contributing most to the high vulnerability score in this subdistrict were density of the built environment, social structure of the community and aging population and social dependence.

Charlotte Amalie was the most densely built subdistrict in the U.S. Virgin Islands with 2,704.4 housing units per square mile. It also had the highest percentage of renter occupied housing units (73%) and the highest number of physicians per 1,000 people

(3.6) in St. Thomas, second highest in the U.S. Virgin Islands (second to Christiansted in St. Croix). Charlotte Amalie also had the highest percentage of the population not owning a vehicle (41.6%) in St. Thomas.

Charlotte Amalie had the second highest percentage foreign born (42.1%) and the highest percentage of the population that did not have citizenship (18.7%) in St. Thomas. Of the foreign born population, 95.9% came from the Caribbean region. Charlotte Amalie had the largest Hispanic or Latino population in St. Thomas (10.4%) and the highest percentage of the population that spoke English less than “very well” (9%). Of the population that spoke a language other than English, the majority spoke Spanish (13.2%, about half or 6.8% of the Spanish speaking population spoke English less than “very well”) followed by French or French Creole (6.5%). Charlotte Amalie Subdistrict also had the second highest birth rate in St. Thomas (16.6).

Charlotte Amalie Subdistrict had the largest percentage of the population age 65 and over (10.1%) and had the second highest percentage receiving social security income (17.6%). Charlotte Amalie also had the highest percentage of the population that was disabled (17.7%).

Although economic status was not found to be one of the more influential component categories for Charlotte Amalie, it still warranted a closer look. Charlotte Amalie had the highest percentage of the population with less than a twelfth grade education (48.9%) in St. Thomas and was also among the highest in the U.S. Virgin Islands. Charlotte Amalie also had the highest percentage of the population in poverty (33.4%) and had the lowest percentage of the population earning more than $75,000 per year (5.2%). The unemployment rate was second highest (5.2%), second to Southside

Subdistrict. Per capita income was lowest in Charlotte Amalie ($10,363) and the median dollar value of owner-occupied housing was also lowest ($144,800). Charlotte Amalie also had the third highest percentage of the population on public assistance (5.5%).

Water Island was the least vulnerable subdistrict with a Social Vulnerability Index score of -4.58. This score was far below any other subdistrict in St. Thomas and was the lowest in all three of the islands. Water Island had the lowest component scores in the areas of social structure of the community, economic status, aging population and social dependence and occupation.

Water Island had the lowest percentage of blacks (9.3%), Asians (0%), other races (0.6%) and Hispanics or Latinos (3.1%). It also had the lowest percentage of foreign born (14.9%), the second lowest percent of the population that were not citizens (8.1%) and the third lowest percentage of the population speaking English less than "very well" (5.1%). Different from all other subdistricts in St. Thomas, Water Island had the highest percentage of the population speaking a language other than English that spoke another Indo-European language (7%), followed by Spanish (4.5%) and French or French Creole (3.8%). Additionally, of the population that spoke another Indo-European language, only 0.6% spoke English less than "very well." The Spanish-speaking population was still the largest population that spoke English less than "very well."

Water Island is a more remote area, considered to be 100% rural by the 2000 U.S. Census. Water Island does not have any commercial development. The median rent ($775) and median dollar value of owner-occupied housing ($250,000) was highest in St. Thomas in 2000. Per capita income was second highest ($19,720) second to Northside Subdistrict. The unemployment rate (2.9%) and the percent in poverty

(14.3%) was third lowest of all the subdistricts in St. Thomas. The percentage of the population participating in the labor force (74.3%) was third highest in St. Thomas and Water Island had the highest percentage of females employed in the labor force (78.5%), which was also highest in the Virgin Islands. Water Island had a highly educated population with only 6.8% of the population earning less than a twelfth grade education, lowest in the U.S. Virgin Islands.

Of all the subdistricts in the U.S. Virgin Islands, Water Island had the lowest percentage of the population employed in the service (10%) and primary extractive (0%) sectors, but the highest percentage employed in the transportation sector (14%). 36% of all jobs were management and professional occupations, followed by sales and office occupations (24%). Interestingly, one-quarter of those participating in the labor market were self-employed (26%).

Water Island also had the lowest percentage of elderly population, aged 65 and over (5%) and the lowest percentage of disabled (10.8%) in the entire U.S. Virgin Islands. Water Island also had the lowest percentage of the population receiving social security income (10%) in St. Thomas, which was second lowest in the U.S. Virgin Islands.

Tutu Subdistrict also had a notably low Social Vulnerability Index Score (-0.05) in comparison to the other subdistricts in St. Thomas and was among the least vulnerable subdistricts in the entire U.S. Virgin Islands. Aiding in Tutu's low vulnerability score were its cultural and ethnic composition.

Tutu Subdistrict had the second lowest percentage of the population of other races (1%) in the U.S. Virgin Islands, second only to Water Island. Tutu also had a small population of Hispanics or Latinos (3.9%) and Asians (0.2%) compared with all other subdistricts in the U.S. Virgin Islands. Tutu had one of the lowest percentages of the population that spoke English less than "very well" (3.4%) of all subdistricts in the U.S. Virgin Islands.

Inconsistent with the results of the low vulnerability score for Tutu Subdistrict were its density of the built environment, social structure of the community and economic status statistics. Tutu Subdistrict had 1,987.1 housing units per square mile, second most to Charlotte Amalie Subdistrict. Tutu also had the highest number of persons per household of all the subdistricts in the U.S. Virgin Islands (3.09).

Of the subdistricts in St. Thomas, Tutu had the highest percentage of the population less than five years of age (8.2%), the highest birth rate (17.5) and the second highest percentage of children enrolled in primary school (20.5%). Tutu had the lowest median age (31.2) in St. Thomas, and the highest percentage of females (55.3%) of all subdistricts in the U.S. Virgin Islands. Tutu also had the highest percentage of female headed households, with no husband present (34%) in St. Thomas and second highest in the Virgin Islands (second to Frederiksted in St. Croix).

Per capita income was lowest in Tutu ($11,061) and median dollar value of owner-occupied housing units was second lowest ($158,300) of all subdistricts in St. Thomas. The percentage of the population receiving public assistance income (5.6%) was second highest in Tutu. The percent of the population earning more than $75,000 per year (8.3%) was lowest in Tutu. Tutu had the second highest number of the population with less than a twelfth grade education (42.1%) of all the subdistricts in St.

Thomas. Tutu Subdistrict had the lowest percentage of the total population (61.9%) and the lowest percentage of the female population (59.7%) participating in the labor force.

4.4 Summary of Results

It was expected that the adjusted Social Vulnerability Index model would be more appropriate for conducting a comparative analysis of social vulnerability in the U.S. Virgin Islands. Indeed, it was decided that the adjusted model was more appropriate for the subsequent analyses in this research because of its inclusion of variables that more accurately represented the social fabric of the U.S. Virgin Islands society.

The original Social Vulnerability Index model (Cutter, Boruff & Shirley 2003) and the adjusted Social Vulnerability Index model produced similar but slightly different pictures of vulnerability in the U.S. Virgin Islands. Both models produced the lowest vulnerability score for Water Island in St Thomas and the highest vulnerability score for Christiansted in St. Croix. Both models also produced the same results for the subdistricts with the highest above average vulnerability scores with East End in St. Croix, Crux Bay in St. John and Northside in St. Thomas. One slightly different result between the two models was that Southside Subdistrict in St. Thomas also had a higher than average vulnerability score in the adjusted model. Both models were consistent in producing Coral Bay and Central Subdistricts in St. John and Tutu in St. Thomas among the lowest vulnerability scores. However, the major differences between the two models occurred in the results for the least vulnerable subdistricts. The original model had Charlotte Amalie and East End in St. Thomas among the lowest, while the adjusted model contained Southcentral in St. Croix and West End in St. Thomas among the lowest.

An expectation of this research was that St. Croix Island would be found to be the most vulnerable island, while St. John Island would be found to be the least vulnerable island in the U.S. Virgin Islands. A Geographic Information System was used to map the mean vulnerability scores for each island. The research expectation held true in that St. Croix was found to be the most vulnerable island of the three islands with the highest mean Social Vulnerability Index score. St. Thomas Island scored just below average and St. John had the lowest mean Social Vulnerability Index score of the three islands. Next, the vulnerability index scores for each subdistrict were mapped by island using both the standard deviation and natural breaks classification schemes. Both maps produced slightly different pictures of vulnerability in the islands, yet examining them both side-by-side yielded comparable results.

It was expected that the three most vulnerable subdistricts in the U.S. Virgin Islands would be Christiansted and Frederiksted in St. Croix and Charlotte Amalie in St. Thomas. Christiansted in St. Croix was found to be the most vulnerable subdistrict in the U.S. Virgin Islands with the highest overall vulnerability score. However, Frederiksted in St. Croix was found to have a below average vulnerability score. The other two most vulnerable subdistricts in the U.S. Virgin Islands were found to be Cruz Bay in St. John and Northside in St. Thomas. Other highly vulnerable subdistricts in the U.S. Virgin Islands included Anna's Hope Village, East End and Sion Farm in St. Croix, East End in St. John, and Charlotte Amalie, East End and Southside in St. Thomas. Water Island in St. Thomas had the lowest overall vulnerability score followed by Coral Bay in St. John. Additionally, Southcentral in St. Croix, Central in St. John and Tutu and West End in St. Thomas were among the least vulnerable subdistricts.

The comparison of subdistricts within each island provided much more detail as to the main reasons why some subdistricts were found to be more vulnerable than others. It was expected that subdistricts with diverse cultural and ethnic populations would be among the most vulnerable. Those that have high percentages of Hispanics, Asians, other races, foreign born and persons speaking English less than “very well” were expected to have higher vulnerability scores. It was also expected that more affluent communities would be less vulnerable than less affluent communities. Additionally, it was expected that the racial and ethnic composition of the islands would reflect the same geographic patterns as the wealth of the communities. It was thought that the more diverse the community the less affluent it would be. Another expectation was that cost of living (e.g. median rent and median dollar value of homes) would reflect the wealth of the individuals or households in the community in that the wealthier the population, the greater the cost of living. A higher economic status was expected to decrease vulnerability, yet it was thought that the wealth of a community might also predict higher levels of vulnerability in that there is more to lose in a disaster event. Finally, it was expected that subdistricts with higher populations of children and higher populations of elderly would be more vulnerable.

The subdistricts in St. Croix Island were analyzed first. Christiansted Subdistrict was found to be not only the most vulnerable subdistrict in St. Croix but also the most vulnerable subdistrict in the entire U.S. Virgin Islands. Christiansted’s high vulnerability score was consistent with expectations of this research. Contributing toward this high level of social vulnerability was density of the built environment, the cultural composition of the subdistrict (particularly with the high percentage of Hispanics and the high percentage of the population speaking English less than “very well”), economic status (particularly with its high unemployment rate and high percentage of the population living in poverty), and the occupational structure (especially with the high percentage of the population employed in service sector jobs).

It was expected that Frederiksted would also be among the most vulnerable subdistricts in St. Croix and in the U.S. Virgin Islands, but this was not the case. Frederiksted had a vulnerability score of 1.84, which was just above the U.S. Virgin Island average (1.58) and below average for St. Croix (2.29). Looking at the data for 2000, Frederiksted's social structure and economic status were expected to have played a larger role in determining its overall vulnerability score. Frederiksted Subdistrict had among the highest values in variables indicating social status (e.g. birth rate, children and females) and variables indicating economic status (e.g. unemployment rate, public assistance and per capita income).

Another notable finding was that East End Subdistrict's vulnerability score (4.18) far exceeded both the St. Croix average and the Island average and was among the highest vulnerability score in the U.S. Virgin Islands. The component that greatly contributed to the high level of vulnerability in East End was aging population and social dependence. It was found that the high percentage of the population 65 years of age and older along with the percentage of the population receiving social security income in East End contributed to its high vulnerability score. Yet, social and economic status statistics indicated that the majority of the population was wealthy and upper-class.

Although Northcentral Subdistrict was found as one of the least vulnerable subdistricts in St. Croix, an examination of the individual variables showed that most of the economic and occupational data was close to the island average. However, its low

Asian population had the greatest effect in lowering its overall vulnerability score. The variables for Southcentral Subdistrict were consistent with its low vulnerability scores in the density of the built environment, preparedness, aging population and social dependence and occupation components.

It was expected that St. John would be the least vulnerable of the three islands because of its affluence, and the results of the comparative analysis of subdistricts within St. John were consistent with research expectations. Cruz Bay was found to be the most vulnerable subdistrict on the island because of its social and economic status and density of the built environment. The analysis of contributing socio-economic statistics for the three other subdistricts of East End, Central and Coral Bay also were consistent with the components scores and the overall vulnerability score for St. John. East End Subdistrict was the second most vulnerable subdistrict in St. John. It had a large aging population reliant on social security and had an overall low economic status. Coral Bay and Central Subdistricts had the lowest vulnerability scores in St. John. Coral Bay had low percentages of ethnic and cultural diversity and a high economic status. Central had a smaller aging population and a higher economic status and was also the least dense of all four subdistricts.

St. Thomas had very inconsistent results. First, Northside Subdistrict was found to be the most vulnerable subdistrict in St. Thomas and one of the most vulnerable subdistricts in the U.S. Virgin Islands. The economic status variables pointed toward a relatively wealthy area with high per capita income and a high percentage of the population earning more than 75,000 dollars per year. Plus, the unemployment rate was the lowest in St. Thomas. The variables with the greatest impact on vulnerability were percent Hispanic, percent other races and percent Asian. In this case, culture and ethnicity played a bigger role in vulnerability than did economic status.

Charlotte Amalie was expected to be among the subdistricts with the highest vulnerability scores both in St. Thomas and in the U.S. Virgin Islands. It was found to be the third-most vulnerable subdistrict in St. Thomas. The components of vulnerability contributing most to the high vulnerability score in this subdistrict were density of the built environment, social structure of the community and aging population and social dependence. Comparing the variables of vulnerability between Charlotte Amalie Subdistrict and Northside Subdistrict, it expected that Charlotte Amalie would have a higher vulnerability score. For instance, Charlotte Amalie was much more densely population and densely built than Northside. Also, Charlotte Amalie had a higher percentage of Hispanics and persons speaking English less than “very well.” Also, the economic status of Charlotte Amalie was much lower than that of Northside, and Charlotte Amalie had a greater aging population.

Southside Subdistrict, on the other hand, had a consistently high vulnerability score, and the components of vulnerability that most attributed toward it were culture and ethnicity, social structure of the community, and density of the built environment. Water Island too had consistent results with the lowest vulnerability score in St. Thomas. Water Island had the lowest component scores in the areas of social structure of the community, economic status, aging population and social dependence and occupation.

Although Tutu was found to have a low vulnerability score, some of the components of vulnerability were inconsistent with this finding. Tutu had low percentages in its ethnic and cultural compositions. Yet, Tutu’s social structure, economic status and density of the built environment alluded to a much more vulnerable place.

In summary, consistent with research expectations were the high vulnerability scores for St. Croix Island and Christiansted Subdistrict in St. Croix and the low vulnerability score for St. John Island. Additionally, density of the built environment, culture and ethnicity, economic status and age demographics played a large role in defining social vulnerability in the islands. The racial and ethnic composition of the islands followed similar geographic patterns as the wealth of the communities and cost of living indicators had similar patterns to economic status. Inconsistent with the research expectations were the low vulnerability score for Frederiksted in St. Croix and the lower vulnerability score for Charlotte Amalie in St. Thomas. There were some anomalies with subdistrict vulnerability scores. In particular, East End in St. Croix was an affluent community with a high economic status, but because of the large aging population it was found to be much more vulnerable than it truly may be. Additionally, Northside in St. Thomas did not have the type of socio-economic composition that would reflect a highly vulnerable place. It had a high per capita income and a low unemployment rate along with lower ethnic and cultural diversity than Charlotte Amalie, which had a lower Social Vulnerability Index score. Charlotte Amalie was also the densest community in St. Thomas, yet it was the third most vulnerable place.

CHAPTER V

DISCUSSION AND CONCLUSIONS

5.1 Overview

This chapter presents a discussion of the major research findings, future directions for this research and conclusions. The applicability of the Social Vulnerability Index for identifying social vulnerability in the United States Virgin Islands is discussed in detail in the first section. The following section details the results of the comparative analysis of social vulnerability between the islands of St. Croix, St. Thomas and St. John and their subdistricts. The reasons why certain areas were found to be more or less vulnerable than other areas are discussed. Several future research objectives are identified and final conclusions are drawn.

5.2 Applicability of the Social Vulnerability Index in the U.S. Virgin Islands

The first objective of this research was to test the applicability of the Social Vulnerability Index methodology within the context of the United States Virgin Islands. The purpose was to explore whether the methodology would be appropriate for measuring social vulnerability in the U.S. Virgin Islands. A key emphasis was on determining which variables were most likely to reflect the social fabric of these islands.

Small-island developing states have long been a focus of academic research because of their unique situations. Insularity and remoteness and repeated exposure to natural hazards cause these small islands to be more vulnerable. Previous research endeavors seeking to understand island-level vulnerability in the Caribbean region mainly focused on physical hazards or on understanding socio-economic vulnerability in a broader global context.   There had been no prior research on community level social vulnerability in the United States Virgin Islands.

The Social Vulnerability Index (Cutter, Boruff & Shirley 2003) is a robust tool for measuring social vulnerability in a society. It has been shown to be effective at predicting the people and places most vulnerable to natural hazards in the United States (Cutter, Boruff & Shirley 2003; Cutter & Finch 2008; Cutter, Mitchell & Scott, 2000). Boruff and Cutter (2007) were the first to expand and apply the Social Vulnerability Index in the Caribbean region. Schmidtlein and others (2008) tested the sensitivity of SoVI and concluded that the method has the ability to withstand changes in scale and variable selection. This research extended the applicability of this methodology into the United States Virgin Islands using subdistricts as the unit of analysis. It was determined that the basic framework for measuring social vulnerability was beneficial, however; adjustments to the selection of input variables were required to fully capture the geography of the region.

Because of the complexity of the social fabric of the U.S. Virgin Islands society, several variables representing the cultural composition of the islands were added. These variables included percent foreign born, percent of the population speaking English less than “very well,” percent of the population without citizenship and percent of the foreign born population that were born elsewhere in the Caribbean region.

Several researchers have contended that the United States Virgin Islands is best characterized as a heterogeneous society with a high level of social and cultural pluralism (deAlbuquerque and McElroy, 1982, 1985, 1999; Roopnarine, 2008, 2010).

For example, various racial, cultural and ethnic groups coincide within defined geographic space and these diverse groups only intermix when necessary (e.g. at work). Each group maintains their own system of beliefs, values and institutional practices and has differing access to wealth, status and power. deAlbuquerque and McElroy (1999) contend that "within the United States Virgin Islands lies a highly complex system of social stratification based on race/color and class, with the two often being coincident" (p.2). This highly stratified social society is a direct reflection on the historical legacy of the Island.

Throughout its history, there have been waves of immigration to the island by various cultural groups in search of economic freedom and financial success. These cultural groups included: French from the island of St. Barthelemy (St. Bart's); Eastern Caribbean Islanders from islands such as St. Kitts, British Virgin Islands, St. Lucia, Dominica, Dominican Republic and Haiti; Hispanics mainly from Puerto Rico; white Americans from the continental United States (referred to as Continentals); and other cultural groups such as Asians, Arabs and Indians (from India). The historical legacy of the U.S. Virgin Islands has resulted in a highly stratified modern day social society. According to Roopnarine (2010) "This plurality in the USVI is a direct result of the legacy of European and American colonialism and imperialism, forced and free migration. The USVI has been at the crossroads where different cultures have met and interacted for centuries. As a result, the current population of just over 117,000 spread across three islands (St. Croix, St. Thomas and St. John), reflects a polygot people from all over the world with different traditions and practices" (p. 792-793).

Attempting to quantify the plurality of the U.S. Virgin Islands society is a difficult task. deAlbuquerque and McElroy (1999) explain why defining discrete ethnic categories in the U.S. Virgin Islands is so difficult.

> (1) Ethnicity is often circumscribed by nativity, colour, jural status ("alien") and socio-economic marginality; (2) groups have multiple identities from which to choose, that is, ethnicity is often situational; and (3) there are numerous instances where ethnic self definitions and definitions by others are at a variance (p.10).

The plural nature of the U.S. Virgin Islands society was somewhat reflected in the Social Vulnerability Index, yet there is much more to the ethnic and cultural compositions of these islands that was not captured. The real underlying cultural diversity in the U.S. Virgin Islands has yet to be quantified at the finite scale required to perform an accurate vulnerability analysis. The demographic data used in this study to measure social vulnerability by subdistrict was derived from the U.S. Census and had to conform to Census designated racial and ethnic categories. As a result, the ethnic and racial composition of the U.S. Virgin Islands was highly generalized, yet still had the ability to show how the social structure of the community plays an important role in defining social vulnerability. With the additional cultural variables, an accurate, although somewhat generalized, picture of social vulnerability emerged.

Since the United States Virgin Islands is a tourist destination and has a large transient population (part-year residents), it was determined that additional variables were needed to capture this important portion of the community. In a review of the racial and ethnic correlates in the United States Virgin Islands, deAlbuquerque and McElroy (1999) contend that a large portion of the white population are transient, in that they are part time residents or live on boats (referred to as "yachties"). The "yachtie" population has historically been undercounted in the censuses. The added variables included percent of housing units that are used for seasonal, recreational or occasional use only and percent of housing units that are boats, recreational vehicles (RVs), vans, etc. These additional dwelling type variables also replaced the percent mobile homes variable because it did not load highly (greater than 0.5) on any component group. There are so few mobile homes in the U.S. Virgin Islands that including it as a measure of vulnerability would be inaccurate.

It was recognized that the tourist population and the tourism industry are somewhat underrepresented in this study. Vacationers and cruise ship passengers are likely to be the least prepared for a natural disaster, and if not given time to evacuate, they have the potential to be extremely vulnerable. There is ample tourism data available (e.g. cruise passengers, daily visitors, stay over visitors, number of occupied hotel rooms, number of hotel beds, visitor spending etc.), but it is collected mainly for the United States Virgin Islands as a whole, or for the individual islands of St. Croix, St. John and St. Thomas. Unfortunately, this data was not available at the subdistrict level, which was a defining criterion in this study.

Preparedness is an important component of vulnerability that was not addressed in the Social Vulnerability Index model (Cutter, Boruff & Shirley, 2003). The level of one's preparedness has the ability to either exacerbate vulnerability to a disaster or to improve upon it (the more prepared you are the less vulnerable you should be). After consulting with emergency preparedness officials, Boruff and Cutter (2007) found several indicators of preparedness to be significant predictors of vulnerability in the Caribbean islands of St. Vincent and Barbados. As a reflection, this research added several indicator variables that were thought to represent preparedness in the U.S. Virgin Islands. These variables included percent of homes cooking with electricity, percent of homes cooking with alternative methods (gas, fuel oil or kerosene, wood or charcoal and other methods), percent of homes not receiving public water (instead using cisterns, tanks or drums, or other sources), percent of homes built prior to 1989, percent of homes with no telephone service, and percent of homes not owning a vehicle,.

After Hurricane Hugo (a Category 4 storm) in 1989 left a wake of devastation in the Virgin Islands, the Virgin Islands government and the Federal Emergency Management Association (FEMA) worked together to identify mitigation measures for future storms. These programs included upgrading building codes and building practices, enhancing the power grid, and instituting public outreach programs educating the community on the value of preparedness measures (www.fema.gov). The new building code requires anchoring systems, hurricane clips, shutters and other hurricane resistant measures on all new construction. Also, as a result of damage to the power grid sustained from high winds from both Hurricane Hugo (1989) and Hurricane Marilyn (1995), the Government of the Virgin Islands decentralized the power generation system and diversified fuel resources. According to FEMA,

> when Hurricane Georges struck in 1998, damage to private homes on the island was less than two percent and all of the power substations and other projects constructed since Hurricane Hugo survived undamaged (www.fema.gov/news/disasters).

Keeping this new legislation in mind, a conclusion was drawn that homes built prior to 1989 would be more vulnerable than those built after the new legislation, and thus was included as an indicator variable. It was recognized that homeowners with homes built prior to 1989 might also have integrated some of these new mitigation strategies, but data is not collected on home improvements and thus could not be reflected in this study.

The U.S. Virgin Islands landscape controls the sources of water and electricity for residential homes. Residential housing units located within a town have access to public water and the public power grid. Homes built in more remote areas must cook with alternative fuel sources and collect and store rainwater in cisterns or purchase water from a vendor. In fact, the majority of homes in the U.S. Virgin Islands store water in cisterns and/or tanks or drums because there is only one desalinization plant on the island. The new storm mitigation legislation established major adjustments to the power grid and availability of diverse fuel sources. Therefore, it was felt that homes cooking with alternative fuels would be more vulnerable than those cooking with electricity because the power grid would be restored much quicker in the aftermath of a disaster event. It was also thought that homes with their own rainwater collection systems (e.g. cisterns) would be less vulnerable than those homes relying on the public water system. Since most cisterns, tanks or drums are stored underground, they are built to withstand major storms. Also homeowners must purchase large quantities of water from a vendor or collect and store rainwater throughout the year, so they should still have access to a large supply of fresh water in the aftermath of a disaster event.

It was expected that the percent of homes with no telephone service would represent households with low socio-economic status and would also reflect the preparedness of households. However, after running the PCA, this variable did not load highly on any one component (did not have a component loading greater than 0.5), so it was excluded from the analysis.

Percent of housing units not owning a vehicle was added as an indicator of preparedness. Thinking in the context of Hurricane Katrina in the United States, a large portion of the people that required rescuing were those that could not evacuate because they did not own a vehicle. Interestingly, the PCA grouped this variable with other density of the built environment variables such as housing units per square mile, rather than with the preparedness variables. This makes sense as it is the more densely population major towns that have less households owning their own vehicle, as most everything is easily accessed by walking or public transportation. From an island perspective, owning a vehicle may not necessarily aid in evacuation prior to a major storm as the islands are completely surrounded by water and the only way off the island is by plane (or boat). Therefore, percent of homes owning a vehicle is not a proper way to measure preparedness in the U.S. Virgin Islands, yet it did aid in defining vulnerability as a consequence of a densely built environment.

There are some fundamental issues with quantifying social vulnerability in the form of an index. In a critique of the South Pacific Applied Geoscience Commission's (SOPAC) Environmental Vulnerability Index (EVI), Barnett, Lambert and Fry (2008) concluded that smaller scale and place based assessments were much more appropriate for providing meaningful interpretations of vulnerability and environmental change. Although these smaller scale analyses were more likely to represent reality than those at larger scales, they argued that there are still complex drivers of vulnerability that are not able to be captured by an index. Additionally, the method of choosing representative indicators of vulnerability is often subjective and requires extensive review of prior research and consultation with emergency management professionals (or someone with extensive knowledge of the study area).

Furthermore, King (2000) identified limitations of socioeconomic indicators of vulnerability at the community level. The most fundamental issue lies within the use of census collected data to identify vulnerability within populations. The Census designates boundaries of communities for data collection, yet smaller communities often develop within these designated places or some communities may even cross boundary lines. Also, population data must be aggregated to avoid exposing identification of individuals. Data aggregation often causes unidentifiable links between socioeconomic characteristics and other vulnerability related indicators (e.g. dwelling type).

Despite the noted limitations, measuring social vulnerability in the U.S. Virgin Islands with the Social Vulnerability Index was deemed appropriate. The Social Vulnerability Index (Cutter, Boruff & Shirley, 2003) is the most robust tool available for measuring social vulnerability to natural hazards at smaller scales, and the U.S. Census is the most extensive dataset available for social and economic data in the U.S. Virgin Islands. The vulnerability assessment was conducted at the smallest possible scale without compromising the availability and accuracy of data. Adjustments were made to the model by incorporating additional indicator variables more suited to the study area, resulting in a comprehensive depiction of social vulnerability in the U.S. Virgin Islands. This was the first attempt at measuring social vulnerability in the United States Virgin Islands, and will serve as a stepping stone for future research.

5.3 Comparative Analysis of Social Vulnerability in the U.S. Virgin Islands

The second objective of this research was to conduct a comparative analysis of social vulnerability within and between the islands of St. Croix, St. John and St. Thomas. This research was interested in accurately depicting social vulnerability within and between the islands using the adjusted Social Vulnerability Index methodology. The main purpose was not only to determine which of the three islands was the most vulnerable, and which subdistricts within each island were the most and least vulnerable, but why.

Social vulnerability between and within the islands of St. Croix, St. John and St. Thomas was measured using the adjusted Social Vulnerability Index. In order to derive this Index, a Principle Components Analysis (PCA) was run on a dataset of 48 carefully selected indicator variables to represent social vulnerability in the United States Virgin Islands. The PCA generated eight components that broadly represented the underlying themes of social vulnerability present in the larger dataset. These components of vulnerability included social structure of the community, economic status, density of the built environment, preparedness, culture, aging population and social dependence, occupation and ethnicity. The component scores were added together to create an overall index score that was unique to each subdistrict within the islands of St. Croix, St. John and St. Thomas. The Index scores for each subdistrict were then mapped in a Geographic Information System. These maps allowed for a comparison of social vulnerability between the three islands and within each island. The purpose of the comparative analysis was to identify the broad categories of vulnerability that most influenced each score in order to define the most influential causes of social vulnerability in the United States Virgin Islands.

Several research expectations were confirmed, although there were a few surprises. St. Croix was expected to be the most vulnerable island, while St. John was expected to be the least vulnerable island, and this proved true. Additionally, it was expected that Christiansted and Frederiksted in St. Croix and Charlotte Amalie in St.Thomas would be the most vulnerable subdistricts in the U.S. Virgin Islands. Christiansted was found to be the most vulnerable subdistrict in the entire U.S. Virgin Islands. However, Charlotte Amalie was found to be more vulnerable than average, but it was not among the most highly vulnerable subdistricts. The most precarious of the findings was that Frederiksted had a lower than average vulnerability score when it was expected to be amongst the highest of all the subdistricts in the U.S. Virgin Islands.

It was also expected that subdistricts with diverse cultural and ethnic populations would be amongst the most vulnerable. Those having the highest percentages of Hispanics, Asians, other races, foreign born and persons speaking English less than "very well" were expected to have high vulnerability scores. Additionally, more affluent communities were expected to be less vulnerable than less affluent communities. It was also expected that the racial and ethnic composition of the islands would reflect the same geographic patterns as the wealth of the communities, and in turn would have the same influence on vulnerability. For instance, the more diverse the community the less affluent it was expected to be, and as a result the more vulnerable.

Another expectation was that cost of living (e.g. median rent and median dollar value of homes) would reflect the wealth of individuals or households in the community in that the wealthier the population, the greater the cost of living. A higher economic status was expected to decrease vulnerability, yet it was also considered that the wealth of a community might also predict higher levels of vulnerability in that there is more to lose in a disaster event. Finally, it was expected that age demographics of subdistricts would be a predictor of vulnerability, with higher populations of children and elderly being more vulnerable. The majority of these expectations held true, but when conducting the within island comparative analysis of subdistricts, some precarious findings emerged. These will be discussed in detail in the following section.

5.3.1 A Cross Island Comparison of Social Vulnerability

The adjusted Social Vulnerability Index allowed for a comparison of social vulnerability between the islands of St. Croix, St. John and St. Thomas. The Index is a construct of socio-economic indicators, so it was expected that the island having an overall combination of low economic status, large population of minority groups, and a large aging population would be the most vulnerable. Consistent with these expectations, St. Croix was found to be the most vulnerable island, followed by St. Thomas, while St. John was found to be the least vulnerable island.

The large population of minority groups such as Hispanics, Asians and other races and the large foreign born and non-English speaking populations contributed to St. Croix's high vulnerability score and the large percentage of whites and native citizens and lower percentages of ethnic minorities contributed to St. John's low vulnerability score.

St. Thomas had a diverse racial and ethnic composition, but was somewhat more homogenous than St. Croix and somewhat more heterogeneous than St. John, placing it in the middle. There are three racial and ethnic indicators in which St.Thomas had the highest percentages; the percent black population, the percent foreign born population, and the percent of the population that are not citizens. A large majority of these populations are immigrants from Eastern Caribbean Islands that have come to live in St. Thomas work for the tourism industry. Many Eastern Caribbean Islanders maintain citizenship in their home countries, but live and work in the Virgin Islands, and often return to their homeland when they are ready to retire (Roopnarine, 2010). Immigrant populations from the West Indies are often overrepresented in housing projects and make up a large majority of the lower class (deAlbuquerue & McElroy, 1982). Because of the West Indian immigrant prevalence in St. Thomas, it seemed as if the Social Vulnerability Index score for that island might have been under calculated. But because this was a comparison between the islands, St. Croix's higher population of minority groups outweighed the immigrant presence in St. Thomas, giving it a higher Index score.

Minority groups are consistently linked to low economic status and lower skilled occupations. A review of demographic trends in the U.S. Virgin Islands conducted by deAlbuquerque and McElroy (1999) found that when compared to whites, blacks and Hispanics were associated more so with low socio-economic status, in that they have higher unemployment rates, larger households and families, more single parent households, are less well educated, have lower labor force participation rates, tend to be more concentrated in blue collar and service occupations, and are more likely to live in poverty (p.17).

A connection between ethnicity and occupation also exists in the U.S. Virgin Islands. Puerto Ricans were heavily represented in the manufacturing and construction trade, and native-born Virgin Islanders occupied a majority of the Federal and local government jobs. Eastern Caribbean immigrants filled a large portion of the lower-paying wage labor occupations, which resulted from their historical legacy on the island. For example, Anguillans and St. Lucians were employed mainly in the construction trade, Trinidadians in manufacturing (particularly with Hess Oil in St. Croix), and Anguillans, Kittitians and Nevisians in service occupations (e.g. domestics, hotel workers).

In 2000, the economic conditions in St. Croix were far worse than in St. John and St. Thomas. The unemployment rate was higher, the educational attainment rates and percentage of females employed were much lower, the percentage of the population living in poverty and receiving public assistance were much higher, per capita income was the lowest, and the percentage of high income households (those earning greater than $75,000 per year) was the lowest of the three islands. The combination of the prevalence of minority groups with the low socio-economic status of its residents, affirms St. Croix's place as the most vulnerable island in the U.S. Virgin Islands.

St. John on the other hand had the highest economic status of the three islands, confirming its place as the least vulnerable island. Cost of living is greatest in St. John with median rent and median housing price highest of the three islands. It has been contended that the more material possessions you have, the more you stand to lose in a disaster event and thus increases your potential vulnerability. However, the affluent are more resilient and typically recover much quicker in the aftermath of a disaster event. Therefore, the majority of researchers argue that the affluent are the least vulnerable, which is also the contention in this research.

The aging population and social dependence data follows similar trends to the socio-economic status data. The three islands had similar percentages of elderly and children, yet St. Croix had the highest percentage of the population that was disabled and receiving social security income, whereas St. John had the lowest percentages in these same categories. An important conclusion can be drawn here. Being elderly does not necessarily make a person more vulnerable. It is a combination of economic status coupled with old age, and the potential for disability that causes a person to be more vulnerable. St. Croix is more vulnerable because a larger portion of the elderly living there are lower income, whereas St. John is less vulnerable because a large portion of the elderly are wealthy retirees.

The U.S. Virgin Islands economy is dominated by the tourism industry. In all three islands almost one-quarter of all those employed work in service occupations. St. John has the highest percentage of the population employed in the service industry, followed by St. Thomas and then St. Croix. Combined, sales and office occupations and management and professional jobs represented almost one-half of all jobs for all three islands. In both St. Thomas and St. John, the most dominant industry was arts, entertainment, recreation, accommodation and food services. Although not the prevailing industry, it should be noted that St. Croix has a large manufacturing presence. One of the world's largest petroleum refineries (HOVENSA, a division of the U.S. based Hess Corporation) is located in St. Croix, in the Southcentral Subdistrict. The Cruzan Rum Distillery (makers of Cruzan Rum and other liquors such as South Comfort) is located in Frederiksted. Also, Harvey Aluminum has a large bauxite mining plant in St. Croix. Because all three islands are economically dependent upon one major sector (tourism), this makes them all equally vulnerable in this category. However, the combination of single-sector economic dependence with other factors such as wealth of the community and the presence of racial and ethnic minorities defines the overall vulnerability of place, further affirming St. Croix's position as the most vulnerable island in the U.S. Virgin Islands followed by St. Thomas and then St. John.

5.3.2 Summary of the Cross Island Comparison of Social Vulnerability

It was the combination of all the social and economic factors of a community that influenced the social vulnerability score for each island. St. Croix was found to have the highest percentages of minority groups, the lowest socio-economic status, and the highest percentage of socially dependent elderly of the three islands, and thus was the most highly vulnerability of the three islands. St. John was the mirror opposite of St. Croix in that it was the most socially homogenous and the most affluent of the three islands and thus was the least vulnerable. St. Thomas had a combination of highs and lows, which affirmed its intermediate level of vulnerability.

Wealth enables individuals and communities to recover quicker in the aftermath of a disaster event. The wealthier the community, the more resources there are available to aid in recovery efforts. Typically the wealthy have more absorbative capacity because of insurance, entitlements and lifelines. Some have argued that the more material possessions a person has, the more they stand to lose, but the general consensus among vulnerability scientists is that it is the socially marginal and economically depraved that suffer the largest losses in a disaster event, are less resilient, and take longer to recover.

Cultural and ethnic barriers cause problems in disaster events. When there are language barriers within a community, it makes distributing public service information all the more difficult. Also, many ethnic and cultural communities keep to themselves and do not integrate into society, expect when necessary (e.g. for work). Because of this, it is harder for governments and emergency preparedness officials to distribute information effectively, and it may be harder for these people to access recovery supplies in the aftermath of a disaster event. Social networks are strong within the communities, but it is often necessary to reach outside of your own network to access recovery resources. It is often the case that ethnic minorities live in low income housing and in high hazard areas because they are affordable. This marginalization puts these people at greater risk.

St. Croix, St. Thomas and St. John are all single-sector economies, reliant mainly on tourism and are thus all equally as vulnerable to a natural disaster in this particular category. According to Cutter, Boruff and Shirley (2003),

> a singular reliance on one economic sector for income generation creates a form of economic vulnerability. The boom and bust economies of oil development, fishing or tourism are good examples-in the heyday of prosperity, income levels are high, but when the industry sees hard times or is affected by a natural hazard, the recovery may take longer (p.253).

Also, certain occupations are more vulnerable than others. Those employed in resource extraction may be severely impacted by a disaster event due to loss of the means of production. Alternately, those employed in low-skilled service sector jobs may similarly suffer as disposable income fades and the need for certain services decline.

The combination of multiple factors such as large minority populations, low economic status, a large percentage of socially dependent elderly, a single-sector reliant economy and lack of a diversified job pool has caused the island of St. Croix to be more vulnerable to natural hazards than St. Thomas and St. John. St. John is the mirror opposite of St. Croix in terms of wealth of the community and social structure, but it too is heavily reliant on a single economic sector and lacks a diversified job pool. St. John was the least vulnerable of the three islands, but this does not mean that it would not suffer large losses if a natural disaster were to strike. The social and economic composition of St. Thomas is a mixture of both St. Croix and St. John.

5.3.3 Inter Island Comparison of Social Vulnerability

The comparative analysis of social vulnerability by subdistrict allowed for a more detailed understanding of the underlying causes of vulnerability within each island. Social vulnerability index scores were calculated for each subdistrict and then ranked in order from highest to lowest to determine the most and least vulnerable subdistricts. The individual component scores were also mapped to show which categories of vulnerability had the greatest and least emphasis on the subdistricts' vulnerability scores.

The three subdistricts expected to have the highest vulnerability scores were Christiansted and Frederiksted in St. Croix and Charlotte Amalie in St. Thomas. Christiansted Subdistrict in St. Croix was found to be the most vulnerable subdistrict of all the subdistricts in the U.S. Virgin Islands. Frederiksted in St. Croix, on the other hand, was found to have a below average vulnerability score when compared with all other subdistricts in St. Croix and just above average for the U.S. Virgin Islands. Charlotte Amalie in St. Thomas was found to have an above average vulnerability score in comparison to all other subdistricts in St. Thomas, yet it was not amongst the highest in the U.S. Virgin Islands. The subdistricts having the highest vulnerability scores in the

U.S. Virgin Islands were Christiansted Subdistrict in St. Croix, Cruz Bay in St. John and Northside in St. Thomas. The subdistricts in the U.S. Virgin Islands found to have the lowest vulnerability scores were Water Island in St. Thomas and Coral Bay in St. John. Other highly vulnerable subdistricts in the U.S. Virgin Islands included Anna's Hope Village, East End and Sion Farm in St. Croix, East End in St. John and Charlotte Amalie, East End and Southside in St. Thomas. Other subdistricts among the least vulnerable in the U.S. Virgin Islands were Southcentral in St. Croix, Central in St. John and Tutu and West End in St. Thomas.

Looking solely at density of the built environment, the three subdistricts of Charlotte Amalie, Christiansted and Frederiksted would have been the most vulnerable in the U.S. Virgin Islands. Charlotte Amalie Subdistrict in St. Thomas was the most densely built of all subdistricts in the U.S. Virgin Islands (measured by housing units per square mile), and Christiansted was a close second. Frederiksted Subdistrict in St. Croix is the third densest subdistrict in the U.S. Virgin Islands. Population density follows a similar structure, in that Charlotte Amalie in St. Thomas has by far the largest total population (and persons per square mile) of any place in the U.S. Virgin Islands, with Frederiksted and Christiansted following a close second and third. These three subdistricts also had the highest percentages of renter occupied housing units and persons not owning a vehicle. Accounting for density of the built environment alone, Charlotte Amalie, Christiansted and Frederiksted should be the most vulnerable subdistricts in the U.S. Virgin Islands. To reiterate, social vulnerability is a construct of a myriad of factors, so it is the combination not the individual components that define a place's vulnerability.

The age structure of the subdistricts made an important contribution toward the overall vulnerability scores for each island. For instance, St. Croix had the top six subdistricts, of the twenty subdistricts in the U.S. Virgin Islands, with the highest percentages of children under five years old (Frederiksted having the highest percentage). Additionally, St. Croix had ten of the eleven subdistricts with the highest percentages of children enrolled in primary schools (Frederiksted was again at the top of the list). The elderly population (age 65 and over) had a much more even distribution. East End in St. Croix had the largest population, followed closely by East End in St. John and Charlotte Amalie in St. Thomas. St. Thomas had two of the smallest populations of elderly, in the Water Island and West End Subdistricts.

It was noted in the cross island comparison of vulnerability that it is not necessarily the percentage of elderly that causes a place to be vulnerable, but the percentage of elderly that are heavily reliant on government support for income. Several of the subdistricts in St. Croix that had large percentages of elderly also had high percentages collecting social security (e.g. Southwest, Christiansted, Anna's Hope Village and Sion Farm). Both Tutu and Charlotte Amalie in St.Thomas had significant elderly populations that were also reliant on social security income. In contrast, East End and Coral Bay in St. John had large populations of elderly, but less that were dependent upon social security income.

Economic status was shown to have a major impact on a place's level of vulnerability. It was expected that the wealthier communities would have lower vulnerability scores than the less affluent communities. Among the wealthiest communities in the Virgin Islands were East End in St. Croix, Northside and West End in

St. Thomas and Central Bay, Cruz Bay and East End in St. John. East End in St. Croix had the highest per capita income and the largest percent of the population earning more than $75,000 per year of all subdistricts in the U.S. Virgin Islands, followed by Northside in St. Thomas. In fact, more than one-quarter of East End's (in St. Croix) population earned more than $75,000 per year. The four subdistricts in St. John all had within the top ten highest per capita incomes in the U.S. Virgin Islands (Central being third highest). Also having among the highest per capita income were Water Island and West End in St. Thomas. Southside and West End in St. Thomas both also had greater than fifteen percent of the population earning more than $75,000 per year.

In contrast to the extremely wealthy communities noted above, were the more impoverished communities in the U.S. Virgin Islands. Seven of the nine subdistricts in St. Croix had one-third or more individuals living in poverty (Christiansted, Frederiksted, Northcentral, Northwest, Sion Farm, Southcentral and Southwest). In fact, over half of the total population in Frederiksted was in poverty (58%) and just under half of the population in Christiansted was living in poverty (48.3%). Additional subdistricts with around one-quarter of the population living in poverty included Charlotte Amalie, Southside, Tutu and East End in St. Thomas and Coral Bay in St. John. The percent of the population collecting public assistance income followed a very similar pattern. Again, seven of the nine subdistricts in St. Croix had the greatest percentages collecting public assistance. Frederiksted had the largest percentage of the population collecting public assistance income of all the subdistricts in the U.S. Virgin Islands. The very same seven subdistricts in St. Croix had the highest unemployment rates, with Christiansted having the highest unemployment rates in the U.S. Virgin Islands (followed closely by Frederiksted).

Racial, cultural and ethnic composition contributed largely to the subdistrict vulnerability scores. As a whole, the island of St. John had the largest white population, but the subdistricts of Water Island in St. Thomas and East End in St. Croix were the communities with the greatest percentage of whites. Water Island also had the greatest percentages of boats followed by all four subdistricts in St. John and East End in St. Thomas. Also East End in St. John and East End in St. Croix had the greatest percentages of vacation homes followed by the remaining three subdistricts in St. John and Water Island and East End in St. Thomas. These statistics attempted to capture the white “yachtie” population and the transient population (mainly white “continentals”).

In direct contrast, Water Island in St. Thomas and East End in St. Croix had the smallest percentages of blacks, followed by East End, Central and Coral Bay in St. John. The largest percentages of blacks (greater than 80% of the total population) were in Tutu and Charlotte Amalie in St. Thomas and Frederiksted and Northwest in St. Croix. Ten of the twenty subdistricts in the U.S. Virgin Islands had a black population representing at least three-quarters of the total population and fifteen of the twenty subdistricts had a black population comprising at least half of the total population. Water Island in St. Thomas was the only subdistrict in the entire U.S. Virgin Islands to have a black population comprising less than one-third of the total population. It can be argued that to be black in the U.S. Virgin Islands does not necessarily exacerbate a person’s vulnerability status as it does in the United States because it is not a minority group. Typically minority status is said to contribute to one’s level of vulnerability, but in the U.S. Virgin Islands it is culture and ethnicity that defines vulnerability and not necessarily race. As a direct reflection on the historical legacy of these islands, it is immigrant status and ethnicity or nationality that creates socially marginal populations in the U.S. Virgin Islands.

The largest Hispanic or Latino populations are found in St. Croix. In St. Croix, the subdistricts of Southcentral, Christiansted, Southwest, Northcentral, Sion Farm and Frederiksted had approximately one-fifth of the total population composed of Hispanics (mainly from Puerto Rico). The three subdistricts of Central, East End and Coral Bay in St. John had the smallest Hispanic populations. Interestingly, all of the subdistricts in St. Croix had more Hispanics than either St. Thomas or St. John. Besides Cruz Bay in St. John, all of the subdistricts in St. Thomas had more Hispanics than St. John. Additionally, despite one subdistrict in St. John (East End) and one subdistrict in St. Thomas (Southside), St. Croix had the largest populations of other racial minorities in all nine subdistricts. The overwhelming majority of individuals that spoke English less than "very well" lived in St. Croix. These statistics are consistent with the large Hispanic populations.

The largest foreign born populations were found in the three subdistricts of East End, Charlotte Amalie and Southside in St. Thomas. Additionally, these same three subdistricts had the greatest populations without citizenship, with the exception of Christiansted in St. Croix, which had the third highest population without citizenship. Eleven of the twenty subdistricts in the U.S. Virgin Islands had a foreign born population comprising at least one-third of the total population (6 of the nine subdistricts in St. Croix, four of the seven subdistricts in St. Thomas and only one of the four in St. John). Of the foreign born population in all but two of the subdistricts, greater than seventy percent came from some other Caribbean Island. The majority of these West Indian immigrants came to the U.S. Virgin Islands in search of better economic opportunity. Water Island in St. Thomas and Coral Bay in St. John are two interesting exceptions: Water Island had a fifteen percent foreign born population, approximately sixty three percent of which came from Europe; and Coral Bay had a ten percent foreign born population, approximately thirty three percent of which came from Europe.

Occupational vulnerability was measured by percent employed in primary extractive industries (mining, fishing, resource extraction, manufacturing), percent employed in transportation and warehousing and related industries and percent employed in service occupations. As stated in the previous section, the U.S. Virgin Islands is largely a single-sector economy reliant on the tourism industry to sustain its economy. St. Croix is somewhat more diversified in the job pool with a manufacturing presence, but it has been contended that manufacturing jobs are also more vulnerable to disasters because of the potential impact on means of production. There were seven subdistricts which had over one-quarter of the population employed in service jobs. Those subdistricts included Christiansted and Frederiksted in St. Croix, all four subdistricts in St. John (Central, Coral Bay, Cruz Bay and East End) and Charlotte Amalie in St. Thomas. Less than two percent of all jobs in the Virgin Islands were in primary extractive industries, but the highest percent of the population employed in those industries were found in East End and Christiansted in St. Croix. The subdistricts with the highest percentages of the population employed in transportation and warehousing jobs were Southcentral and Northcentral in St. Croix, East End in St. John and Water Island and Tutu in St. Thomas.

There are a few inconsistencies between the results of the comparative analysis of social vulnerability within the islands and with the expectations of this research. East End Subdistrict in St. Croix was not expected to be among the most vulnerable, although it had the second highest vulnerability score of all the subdistricts in St. Croix and was third highest in the U.S. Virgin Islands. This result is precarious because a review of the socio-economic statistics for this subdistrict would lead one to believe that it should be among the least vulnerable in the U.S. Virgin Islands. East End was not among the most densely built or populated subdistricts. It had a large white population and a large percentage of vacation homes (used to represent the transient white population). East End in St. Croix was also found to be the most affluent community in the U.S. Virgin Islands. Because East End had a large population of elderly, it received a high vulnerability score. However, a conclusion of this research was that the more affluent elderly are less vulnerable than the poor elderly. East End is a wealthy community composed of mainly white retirees from the United States. Therefore, it should have been amongst the least vulnerable. East End also had the greatest percentage of the population employed in primary extractive industries, which influenced its high vulnerability score. However, the employment in that sector is less than two percent of the total employment in that subdistrict, and therefore would not create a significant impact in the aftermath of a disaster event. The situation with East End in St. Croix shows that the Index scores can be somewhat misleading, and it is necessary to understand the underlying connection amid the indicator variables for a true representation of social vulnerability.

Northside Subdistrict in St. Thomas was found to have one of the highest vulnerability scores in the U.S. Virgin Islands and the highest vulnerability score in St. Thomas. Northside did not have large populations of children or elderly and was not densely built compared with all other subdistricts in St. Thomas and the U.S. Virgin Islands. Also Northside was found to be among the wealthiest communities in the U.S. Virgin Islands, and did not have large populations of minorities or foreign born. Again, these statistics point toward a less vulnerable place.

Frederiksted was ranked below average in terms of vulnerability in St. Croix and close to average of all subdistricts in the U.S. Virgin Islands. Frederiksted was the third densest subdistrict and had the largest percentage of children in the U.S. Virgin Islands. More than one-fifth or Frederiksted's total population was Hispanic, twelve percent of which spoke English less than "very well." Additionally, Frederiksted had the greatest percentage of the population with less than a twelfth grade education compared with all other subdistricts in the U.S. Virgin Islands. One of the most extreme findings was that over half of the population in Frederiksted was living in poverty. Furthermore, approximately one-quarter of all those employed in this subdistrict were employed in the service sector. Consistent with the expectations of this research, Frederiksted should have been one of the most vulnerable subdistricts in the U.S. Virgin Islands.

Charlotte Amalie in St. Thomas was expected to be amongst the most vulnerable subdistricts in the U.S. Virgin Islands, but its vulnerability score placed it around average for the islands as a whole and just above average compared with all other subdistricts in St. Thomas. Charlotte Amalie is the capital and the population center of the U.S. Virgin Islands. It was had the greatest population density and the densest built environment of all subdistricts in the U.S. Virgin Islands. Charlotte Amalie had a large elderly population that was reliant on social security income and one-quarter of the total population were living in poverty. Additionally, Charlotte Amalie had the largest black population, the largest foreign born population and the largest population without citizenship. One-quarter of all those employed were employed in the service sector. From these statistics, a conclusion can be drawn that there is a heavy West Indian immigrant presence in Charlotte Amalie that are working mainly in low wage service sector jobs. Immigrant status and dependence upon a single-sector economy make a place highly vulnerable, and as such Charlotte Amalie should have had a much higher vulnerability score.

Despite these four exceptions, the adjusted Social Vulnerability Index portrayed an accurate representation of community level social vulnerability in the United States Virgin Islands. Certain characteristics such as density of the built environment, racial and ethnic minority presence, economic status, occupational structure and societal characteristics had a major influence on social vulnerability in the subdistricts of the U.S. Virgin Islands. The greater the prevalence of minority groups coupled with low socio-economic status and a densely built environment defined the most vulnerable subdistricts. A high prevalence of children and elderly also impacted vulnerability scores. However, this statistic alone is misleading, as large populations of elderly were found in wealthy communities, which would actually lower their vulnerability. The poorer more ethnically diverse communities with a greater prevalence of elderly and children were the most socially vulnerable in the U.S. Virgin Islands.

5.4 Future Directions

As noted, the tourism industry and the tourist population were underrepresented in this study. Tourism dominates the U.S. Virgin Islands (and the Caribbean) landscape. As an example, there were 628,153 visitors and 1,768,402 cruise ship passengers that vacationed in the U.S. Virgin Islands in 2000. The total population for the Island was only 108,612. Therefore, there were six times as many vacationers as there were residents over the course of one year. How does this impact vulnerability in the U.S. Virgin Islands? What is the connection between tourism expenditures and the annual revenues for the Island, and how would this be affected if a major natural disaster were to take place? How long does it take for a tourism dependent economy to recover after a major natural disaster? Does the occurrence of a disaster cause fear and in turn influence whether or not a person will vacation to the Island? If so, how long after the event will people begin to return and how long will it take the economy to fully recover? This study uncovered a large transient population living in the U.S. Virgin Islands. These people also have the choice to leave the island if a major natural disaster were to take place and return once the economy and the built environment have restored to normal. How will this impact the local community?

Preparedness is another major component of vulnerability that was somewhat underrepresented in this study. It would be beneficial to measure preparedness with questionnaires sent to local residents and incorporate the results into the adjusted Social Vulnerability Index model for a more accurate representation of social vulnerability in the U.S. Virgin Islands. Preparedness at the individual and community level has the ability to either exacerbate or improve upon a person's vulnerability to a natural hazard. How does a person's prior experience with a natural disaster influence their behavior prior to another event? Because tropical storms and hurricanes are so common in the U.S. Virgin Islands, does this impact how a person prepares prior to an event? How does duration of residency affect a person's behavior?

Another potential research direction would be to examine the dichotomy between citizens of the U.S. Virgin Islands and the immigrant populations and how social tension among these racial and cultural groups affects vulnerability. Does social tension cause marginalization of certain racial and ethnic groups? And if so, how does this affect their vulnerability? There have been several studies conducted that examine racial and ethnic relations between immigrants in the United States Virgin Islands (Roopnarine, 2008, 2010). Roopnarine (2010) defined social identity among residents in the Virgin Islands as either having a national identity (identifying with the Virgin Islands) or a trans-Caribbean identity (identifying with the Caribbean region). How does social identity influence vulnerability? Does associating yourself with another country while living in the Virgin Islands cause you to be outcast from society and thus increase your vulnerability?

5.5 Conclusions

Hazards are no longer solely thought of as inevitable and uncontrollable acts of god. There is instead a human component of hazards that has been at the forefront of geographic research, and the focus of this paradigm shift has been in understanding the human-environment interaction. The environment is considered the agent of disaster while socioeconomic patterns and societal problems of individuals and/or the community define risk and vulnerability. Vulnerability has been regarded as one of the keys to understanding disaster because it is associated with social inequality, past losses and susceptibility to future losses.

In the study of vulnerability, it is thought that social processes generate unequal exposure to risk by making some people more prone to disasters than others. However, vulnerability is not just a property of social groups or of individuals, but is deeply imbedded in complex social relations and processes. In order to understand the complex nature of societal vulnerability, researchers have conducted numerous vulnerability assessments that have the ability to measure vulnerability based on a set of indicators.

Vulnerability assessments have been conducted at many different spatial scales, ranging from the global to the community level. Each scale of analysis has the ability to shed light on what makes places and people living within those places vulnerable. However, it has been concluded by some that a more finite scale is beneficial for truly understanding the fabric of society and its inherent vulnerabilities. There is also a wide body of work focused on identifying the factors that influence social vulnerability. There is a general consensus in the social science community that gender, age, race and ethnicity, housing and built environment, economic status and family structure and social networks are the best indicators of social vulnerability in a community.

There has been numerous vulnerability assessments focused on understanding the inherent vulnerability of small-island developing states, and is especially of concern in the Caribbean region. Much of this research has been one-sided in that it either focused on the economic vulnerability or the environmental vulnerability, but not a combination of the two. To date, there had been no social vulnerability assessments in the United States Virgin Islands.

This research was focused on understanding the underlying causes of social vulnerability in the United States Virgin Islands. The following research objectives were established:

1. Test the applicability of the Social Vulnerability Index methodology within the United States Virgin Islands. Can an index of vulnerability created for the United States be applied in a Caribbean island setting? What variables are appropriate for assessing the social fabric of the Virgin Islands?

2. Conduct a comparative analysis of social vulnerability between and within the islands of St. Croix, St. John and St. Thomas. Will the Social Vulnerability Index allow for an accurate comparison of social vulnerability between and within these islands? Which of the three islands will be the most vulnerable, and why? Which subdistricts within each island will be the most vulnerable, and why?

The Social Vulnerability Index was a powerful tool for measuring social vulnerability in the United States Virgin Islands. Because it was originally designed for measuring social vulnerability in the United States, it required some adjustments for its applicability in the Virgin Islands. Several additional indicator variables of vulnerability were added to better reflect the racial and ethnic composition, housing structure and preparedness in the U.S. Virgin Islands.

The racial and ethnic composition of the community coupled with density of the built environment, social structure and economic status influenced the degree of vulnerability in each subdistrict and in each island. St. Croix Island was found to be the most vulnerable island, mainly due to its large minority populations and lower socio-economic status, whereas St. John Island was found to be the least vulnerable island due in part to its affluence and cultural homogenous social structure. St. Thomas Island had a large prevalence of West Indian immigrants and had a varying degree of affluence among its subdistricts, but was found to be less vulnerable than St. Croix and more vulnerable than St. John.

The comparative analysis between subdistricts within the islands produced mixed results that uncovered the major influential causes of vulnerability in each island, but also exposed some flaws in the methodology. In general, subdistricts that had densely built environments, large population densities, a prevalence of low income minority groups and large concentrations of children and/or elderly were found to be more vulnerable than those with smaller population distributions and more affluent racially and ethnically homogenous communities. An important conclusion is that one indicator such as the elderly population does not have the ability to define vulnerability, but it must be a combination of all indicators to accurately calculate social vulnerability in the U.S. Virgin Islands community.

A major player in defining the social structure and economy of the United States Virgin Islands is tourism. The historical legacy of migration to the U.S. Virgin Islands was driven by the need for laborers, in the early years to support the sugar and cotton industry, and later to support the tourism trade. Today, tourism drives the economy and leaves the U.S. Virgin Islands largely dependent upon one single sector. Although the United States Virgin Islands are considered to be a more affluent island nation, they still are extremely susceptible to natural hazard events. Understanding the social fabric of this society and the underlying causes of vulnerability is one step closer toward establishing proper mitigation strategies that have the ability to increase resilience in the face of disasters and lead toward a sustainable future.

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APPENDIX A

RAW DATA

SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Median Age	Per Capita Income ($)	Median ($) Owner-Occupied Housing Units	Median Rent ($)	Physicians Per 1,000 People	Birth Rate	Percent Black	Percent Native American	Percent Asian
St. Croix									
Anna’s Hope Village	36.30	15684.00	136000.00	574.00	0.00	10.97	68.10	0.38	2.00
Christiansted	33.90	9312.00	121500.00	382.00	18.15	16.75	76.90	0.35	0.40
East End	43.80	28490.00	214900.00	716.00	0.00	9.40	35.20	0.38	0.40
Frederiksted	23.70	7696.00	115300.00	327.00	1.59	24.16	84.30	0.27	0.30
Northcentral	32.20	10873.00	110900.00	437.00	0.00	15.63	76.00	0.33	0.20
Northwest	29.00	10882.00	129800.00	318.00	0.00	19.52	81.90	0.35	0.50
Sion Farm	32.70	13079.00	140500.00	466.00	0.66	15.48	73.50	0.27	1.30
Southcentral	29.30	9777.00	114000.00	383.00	0.74	16.62	69.60	0.68	0.90
Southwest	30.90	9175.00	116100.00	423.00	0.00	14.42	78.00	0.47	0.90
St. Thomas									
Charlotte Amalie	33.60	10363.00	144800.00	535.00	3.60	16.55	88.90	0.20	0.70
East End	34.80	14999.00	174900.00	656.00	1.04	13.69	79.40	0.20	0.50
Northside	37.90	22515.00	231100.00	758.00	0.34	10.79	52.20	0.20	2.90
Southside	32.00	14475.00	190400.00	531.00	1.28	15.18	78.20	0.20	4.60
Tutu	31.20	11061.00	158300.00	560.00	0.00	17.45	96.50	0.10	0.20
Water Island	47.90	19720.00	250000.00	775.00	0.00	6.21	9.30	0.00	0.00
West End	36.40	19171.00	186600.00	712.00	0.00	11.66	79.60	0.10	0.70

St. John									
Central	37.90	21051.00	251500.00	625.00	0.00	9.38	42.00	0.70	0.30
Coral Bay	40.80	16563.00	196300.00	644.00	0.00	13.87	42.40	0.00	0.30
Cruz Bay	35.30	17515.00	256800.00	709.00	2.92	15.68	65.90	0.10	0.70
East End	49.50	18603.00	360000.00	525.00	0.00	16.95	37.30	1.70	3.40

SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Percent Hispanic	Percen t Other Races	Percent Under 5	Percent Over 65	Unemployment Rate	Number Persons Per Household	Percent Earning More Than $75,000/Yr	Percent in Poverty	Percent Renter Occupied Housing Units
St. Croix									
Anna's Hope Village	18.70	16.60	6.30	9.00	4.80	2.57	13.70	21.80	32.40
Christiansted	26.10	15.90	8.40	9.80	9.50	2.29	4.30	48.30	76.60
East End	11.40	7.30	4.40	12.10	2.00	2.18	28.50	19.00	37.80
Frederiksted	19.90	10.50	10.80	6.80	9.20	2.82	4.40	56.80	70.70
Northcentral	22.30	14.90	7.40	8.50	7.70	2.82	7.90	39.80	39.40
Northwest	12.40	7.10	10.30	8.10	7.10	2.71	7.90	46.40	56.40
Sion Farm	21.40	9.70	8.30	9.30	6.60	2.65	10.10	34.30	50.50
Southcentral	26.70	17.10	8.80	6.10	7.10	3.00	8.00	40.30	51.90
Southwest	22.90	11.60	8.70	8.40	7.30	2.87	4.90	41.40	41.30
St. Thomas									
Charlotte Amalie	10.40	4.10	7.70	10.10	5.20	2.56	5.20	33.40	73.00
East End	5.80	3.10	7.30	6.90	4.90	2.58	11.80	26.50	49.40
Northside	6.10	5.80	6.20	7.50	2.40	2.29	20.70	15.70	50.60

Southside	6.50	7.30	8.00	6.80	6.20	2.74	14.90	32.00	64.90
Tutu	3.90	1.00	8.20	9.00	4.90	3.09	8.30	26.90	43.70
Water Island	3.10	0.60	2.50	5.00	2.90	2.01	11.30	14.30	38.80
West End	4.50	3.20	6.80	5.60	2.70	2.57	20.20	12.90	37.70
St. John									
Central	1.20	2.80	5.50	5.80	2.00	2.27	18.20	20.20	53.10
Coral Bay	1.70	2.30	5.40	8.60	2.90	2.13	10.50	27.60	43.60
Cruz Bay	6.80	5.10	7.80	7.10	2.00	2.51	15.30	15.80	55.00
East End	1.70	10.20	3.40	11.90	2.00	1.90	12.90	22.00	32.30

SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY
BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS
DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Percent Rural Population	Percent Mobile Homes	Percent Over 25 Years Old with no Diploma/Less Than Twelfth Grade Education	Housing Units Per Square Mile	Percent Participating in Labor Force	Percent Females Participating in Labor Force
St. Croix						
Anna's Hope Village	5.90	0.80	30.40	192.60	66.00	61.70
Christiansted	0.00	0.10	50.00	2060.80	59.60	54.30
East End	83.90	0.20	13.20	122.90	69.00	62.30
Frederiksted	0.10	0.50	52.30	1181.60	53.80	51.60
Northcentral	17.80	6.60	48.90	186.00	60.40	53.50
Northwest	27.10	0.80	43.50	116.80	60.90	57.40
Sion Farm	0.50	2.90	36.00	676.80	62.50	57.60
Southcentral	0.80	5.20	52.00	249.50	58.00	53.10
Southwest	0.50	1.60	52.00	576.90	58.10	52.30
St. Thomas						
Charlotte	0.00	2.10	48.90	2704.40	64.60	61.90

Amalie						
East End	0.00	0.50	36.70	745.60	73.30	69.30
Northside	1.00	0.20	18.70	446.80	75.90	72.10
Southside	0.00	0.20	36.00	582.60	69.90	65.50
Tutu	0.00	0.30	42.10	1987.10	61.90	59.70
Water Island	100.00	0.70	6.80	148.00	74.30	78.50
West End	81.00	0.20	15.80	184.40	74.70	71.90
St. John						
Central	99.30	1.90	15.50	30.70	78.30	74.30
Coral Bay	100.00	2.30	20.90	200.50	71.00	69.30
Cruz Bay	0.00	0.70	34.70	556.00	79.60	77.10
East End	100.00	2.10	16.20	51.60	56.60	60.70

SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Percent Employed in Primary Extractive Industry	Percent Employed in Transportation and Warehousing	Percent Employed in Service Industry	Per Capita Residents in Nursing Homes	Percent Disabled	Number of Community Hospitals Per 1,000 People
St. Croix						
Anna’s Hope Village	0.40	11.80	16.10	0.00	14.39	0.03
Christiansted	1.30	10.50	27.00	0.00	19.61	0.03
East End	1.70	8.70	16.00	0.00	14.67	0.03
Frederiksted	0.50	9.80	25.80	0.00	16.91	0.03
Northcentral	0.80	13.00	24.20	0.00	17.68	0.03
Northwest	0.50	11.60	23.50	0.00	17.59	0.03
Sion Farm	0.40	11.50	19.10	2.80	17.26	0.03

Southcentral	0.80	17.00	21.10	0.00	16.30	0.03
Southwest	0.60	12.60	20.90	0.00	20.12	0.03
St. Thomas						
Charlotte Amalie	0.50	11.10	27.20	3.86	17.70	0.02
East End	0.60	12.40	24.40	0.00	14.71	0.02
Northside	0.80	7.60	14.40	0.00	13.53	0.02
Southside	0.10	9.80	23.80	5.30	14.98	0.02
Tutu	0.50	13.30	22.80	3.29	14.09	0.02
Water Island	0.00	14.00	10.00	0.00	10.83	0.02
West End	0.70	7.80	16.00	0.49	14.30	0.02
St. John						
Central	0.70	7.00	28.10	0.00	16.76	0.20
Coral Bay	0.30	9.80	25.90	0.00	13.84	0.20
Cruz Bay	0.30	12.70	30.20	0.00	11.87	0.20
East End	0.00	13.30	33.30	0.00	17.54	0.20

SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Population Change From 1990-2000	Percent Urban Population	Percent Female	Percent Female-Headed Households	Percent Receiving Social Security Income
St. Croix					
Anna's Hope Village	14.44	94.10	50.10	20.00	19.00
Christiansted	-10.44	100.00	52.00	26.70	16.20
East End	34.54	16.10	50.00	10.20	18.00
Frederiksted	-7.35	99.90	54.20	42.10	17.40
Northcentral	4.82	82.20	51.80	25.10	17.20

Northwest	1.88	72.90	54.90	31.90	15.40
Sion Farm	14.15	99.50	52.60	25.80	18.30
Southcentral	9.43	99.20	50.90	24.70	15.20
Southwest	-1.79	99.50	52.30	27.40	18.90
St. Thomas					
Charlotte Amalie	-8.14	100.00	53.10	29.30	17.60
East End	29.44	100.00	50.80	20.40	12.50
Northside	36.04	99.00	50.00	13.20	12.50
Southside	17.12	100.00	52.20	24.60	12.30
Tutu	-9.76	100.00	55.30	34.00	18.70
Water Island	-6.40	0.00	43.50	6.30	10.00
West End	55.67	19.00	51.90	16.70	10.90
St. John					
Central	20.13	0.70	50.70	18.80	9.10
Coral Bay	78.79	0.00	49.60	10.50	15.40
Cruz Bay	11.10	100.00	51.60	17.70	12.20
East End	15.69	0.00	52.50	12.90	16.10

ADDITIONAL SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Children Enrolled in Primary School	Percent Cooking with Electricity	Percent Cooking with Alternative Fuels	Percent with no Telephone Service	Percent with no Vehicle	Percent with no Public Water	Percent Boats, RVs, Vans, etc.
St. Croix							
Anna's Hope Village	18.9	30.1	69.6	4.8	9.3	61.4	0.2
Christiansted	18.9	33.0	64.7	17.5	44.2	13.9	0.8

East End	13.5	47.7	51.6	4.1	5.9	91.5	1.2
Frederiksted	29.4	33.5	64.8	13.5	42.9	20.4	0.1
Northcentral	14.4	22.7	76.6	11.5	22.4	56.8	0.5
Northwest	23.5	45.8	53.4	7.8	31.0	53.5	0.0
Sion Farm	20.7	42.7	56.7	7.8	20.3	46.6	0.1
Southcentral	22.8	33.5	65.2	9.6	23.3	49.1	0.0
Southwest	22.4	18.4	80.8	9.3	20.2	45.8	0.0
St. Thomas							
Charlotte Amalie	18.6	35.0	63.5	9.2	41.6	20.4	0.6
East End	18.7	34.7	64.8	7.8	18.3	75.7	2.9
Northside	14.4	42.5	57.1	3.9	7.4	86.5	0.0
Southside	20.9	49.9	49.1	7.5	22.5	62.6	0.0
Tutu	20.5	45.2	54.4	3.4	23.6	66.6	0.0
Water Island	11.2	43.8	56.3	11.3	27.5	83.8	14.2
West End	18.1	47.6	52.3	3.9	8.5	94.5	0.0
St. John							
Central	14.1	23.6	76.3	5.5	16.8	87.5	1.9
Coral Bay	14.3	10.8	86.5	22.6	24.6	92.4	11.5
Cruz Bay	16.5	18.6	80.5	7.4	22.0	78.5	2.2
East End	8.5	22.6	74.2	9.7	16.1	91.5	8.5

ADDITIONAL SOCIO-ECONOMIC INDICATOR VARIABLES FOR MEASURING SOCIAL VULNERABILITY
BY SUBDISTRICT FOR THE ISLANDS OF ST. CROIX, ST. THOMAS AND ST. JOHN, UNITED STATES VIRGIN ISLANDS
DATA DERIVED FROM U.S. CENSUS OF ISLAND AREAS, 2000

Subdistrict Name	Percent Homes Built Prior to 1989	Percent Foreign Born	Percent with no Citizenship	Percent Foreign Born from the Caribbean	Percent Speaking English Less Than “Very Well”	Percent Receiving Public Assistance Income	Percent Homes for Recreational Use Only

St. Croix							
Anna's Hope Village	75.0	30.2	8.0	85.6	8.1	2.9	2.6
Christiansted	93.7	34.0	18.0	95.0	15.4	8.3	2.9
East End	75.7	18.9	4.2	72.5	4.8	0.7	16.4
Frederiksted	81.7	24.8	9.1	96.5	12.0	17.0	0.9
Northcentral	78.5	29.7	8.7	96.6	12.3	9.3	2.9
Northwest	77.5	34.1	12.0	94.9	6.4	12.1	3.4
Sion Farm	78.6	28.2	8.0	90.3	9.2	7.6	4.2
Southcentral	63.1	33.6	9.3	95.6	12.1	9.8	0.9
Southwest	73.1	32.5	9.0	94.8	14.0	9.4	3.7
St. Thomas							
Charlotte Amalie	88.2	42.1	18.7	95.9	9.0	5.5	1.4
East End	74.8	42.4	17.2	93.2	8.3	3.0	12.2
Northside	77.5	26.7	10.1	74.7	4.7	1.7	3.8
Southside	80.6	39.3	16.8	86.0	7.1	5.9	5.8
Tutu	93.0	33.6	9.9	98.4	3.4	5.6	0.4
Water Island	76.5	14.9	8.1	29.2	5.1	1.3	16.2
West End	68.8	25.5	7.0	92.9	3.4	0.9	1.9
St. John							
Central	64.4	14.9	6.2	74.8	4.3	0.6	15.3
Coral Bay	65.9	9.9	5.7	54.7	3.1	1.6	11.2
Cruz Bay	74.5	30.8	13.9	91.4	8.0	2.1	13.9
East End	66.0	10.2	0.0	83.3	5.3	3.2	27.7

APPENDIX B

CORRELATION MATRICES FOR Z-SCORES

Correlation Matrix of Z-Scores for 33 Original Data Variables

Original Model		Zscore (MEDRENT)	Zscore (M_AGE)	Zscore (PCINC)	Zscore (MEDOWN)
Correlation	Zscore(MEDRENT)	1.000	.678	.826	.628
	Zscore(M_AGE)	.678	1.000	.759	.812
	Zscore(PCINC)	.826	.759	1.000	.715
	Zscore(MEDOWN)	.628	.812	.715	1.000
	Zscore(PHYS)	-.279	-.133	-.309	-.222
	Zscore(BIRTH)	-.788	-.682	-.755	-.409
	Zscore(PER_AA)	-.562	-.851	-.725	-.693
	Zscore(PER_NA)	-.277	.313	.067	.433
	Zscore(PER_AS)	.047	.157	.162	.353
	Zscore(PER_HIS)	-.712	-.576	-.602	-.761
	Zscore(PER_OT)	-.642	-.323	-.418	-.456
	Zscore(LESSFIVE)	-.728	-.969	-.770	-.755
	Zscore(OVER)	-.167	.252	.077	.088
	Zscore(UNEMP)	-.871	-.765	-.864	-.825
	Zscore(NUM_HH)	-.540	-.880	-.683	-.748
	Zscore(EARN_MR)	.733	.528	.937	.555
	Zscore(PER_POV)	-.936	-.728	-.829	-.713
	Zscore(RENT_OC)	-.425	-.554	-.482	-.353
	Zscore(RURAL)	.455	.766	.639	.639
	Zscore(MOBILE)	-.364	-.135	-.312	-.249
	Zscore(NO_DIPLO)	-.808	-.848	-.907	-.780
	Zscore(HU_SQMI)	-.255	-.378	-.515	-.366
	Zscore(LABOR)	.860	.409	.689	.480
	Zscore(FE_LAB)	.885	.569	.689	.662
	Zscore(EMP_EXT)	-.048	-.121	.188	-.321
	Zscore(EMP_TRAN)	-.326	-.083	-.469	-.169

	Zscore(EMP_SERV)	-.386	-.153	-.338	.170
	Zscore(NURS)	-.074	-.241	-.227	-.129
	Zscore(DISABL)	-.793	-.410	-.567	-.440
	Zscore(HOSP)	.219	.422	.302	.650
	Zscore(POPCHA)	.525	.366	.567	.309
	Zscore(URBAN)	-.455	-.766	-.639	-.639
	Zscore(FEMALE)	-.630	-.657	-.539	-.361
	Zscore(FEMHEAD)	-.796	-.892	-.829	-.694
	Zscore(SOCSEC)	-.543	-.311	-.446	-.507

Original Model		Zscore (PHYS)	Zscore (BIRTH)	Zscore (PER_AA)	Zscore (PER_NA)
Correlation	Zscore(MEDRENT)	-.279	-.788	-.562	-.277
	Zscore(M_AGE)	-.133	-.682	-.851	.313
	Zscore(PCINC)	-.309	-.755	-.725	.067
	Zscore(MEDOWN)	-.222	-.409	-.693	.433
	Zscore(PHYS)	1.000	.218	.205	-.055
	Zscore(BIRTH)	.218	1.000	.675	.146
	Zscore(PER_AA)	.205	.675	1.000	-.230
	Zscore(PER_NA)	-.055	.146	-.230	1.000
	Zscore(PER_AS)	-.116	-.004	-.033	.377
	Zscore(PER_HIS)	.379	.387	.413	.030
	Zscore(PER_OT)	.323	.319	.233	.385
	Zscore(LESSFIVE)	.225	.772	.864	-.242
	Zscore(OVER)	.191	.178	.011	.406
	Zscore(UNEMP)	.436	.658	.635	-.098
	Zscore(NUM_HH)	-.124	.524	.826	-.270
	Zscore(EARN_MR)	-.335	-.648	-.486	.016
	Zscore(PER_POV)	.369	.783	.551	.046
	Zscore(RENT_OC)	.628	.523	.445	-.235
	Zscore(RURAL)	-.282	-.512	-.771	.272
	Zscore(MOBILE)	-.198	.139	.024	.266
	Zscore(NO_DIPLO)	.344	.756	.803	-.086
	Zscore(HU_SQMI)	.570	.427	.568	-.258

	Zscore(LABOR)	-.175	-.702	-.399	-.410
	Zscore(FE_LAB)	-.217	-.670	-.532	-.286
	Zscore(EMP_EXT)	.371	-.109	.083	-.075
	Zscore(EMP_TRAN)	-.054	.241	.086	.202
	Zscore(EMP_SERV)	.277	.596	.263	.447
	Zscore(NURS)	-.011	.181	.420	-.222
	Zscore(DISABL)	.360	.501	.432	.448
	Zscore(HOSP)	-.089	-.050	-.433	.401
	Zscore(POPCHA)	-.321	-.383	-.316	-.114
	Zscore(URBAN)	.282	.512	.771	-.272
	Zscore(FEMALE)	.102	.803	.809	.170
	Zscore(FEMHEAD)	.198	.819	.838	-.083
	Zscore(SOCSEC)	.073	.466	.410	.128

Original Model		Zscore (PER_AS)	Zscore (PER_HIS)	Zscore (PER_OT)	Zscore (LESSFIVE)
Correlation	Zscore(MEDRENT)	.047	-.712	-.642	-.728
	Zscore(M_AGE)	.157	-.576	-.323	-.969
	Zscore(PCINC)	.162	-.602	-.418	-.770
	Zscore(MEDOWN)	.353	-.761	-.456	-.755
	Zscore(PHYS)	-.116	.379	.323	.225
	Zscore(BIRTH)	-.004	.387	.319	.772
	Zscore(PER_AA)	-.033	.413	.233	.864
	Zscore(PER_NA)	.377	.030	.385	-.242
	Zscore(PER_AS)	1.000	-.159	.179	-.124
	Zscore(PER_HIS)	-.159	1.000	.858	.572
	Zscore(PER_OT)	.179	.858	1.000	.333
	Zscore(LESSFIVE)	-.124	.572	.333	1.000
	Zscore(OVER)	.144	.141	.266	-.142
	Zscore(UNEMP)	-.131	.808	.611	.768
	Zscore(NUM_HH)	-.116	.495	.273	.810
	Zscore(EARN_MR)	.243	-.491	-.314	-.551
	Zscore(PER_POV)	-.172	.713	.541	.763
	Zscore(RENT_OC)	-.027	.258	.061	.598

	Zscore(RURAL)	-.130	-.580	-.409	-.766
	Zscore(MOBILE)	-.145	.413	.442	.059
	Zscore(NO_DIPLO)	-.154	.722	.522	.861
	Zscore(HU_SQMI)	-.172	.178	-.057	.401
	Zscore(LABOR)	.005	-.656	-.639	-.458
	Zscore(FE_LAB)	.044	-.795	-.727	-.596
	Zscore(EMP_EXT)	-.353	.395	.279	.115
	Zscore(EMP_TRAN)	-.109	.345	.335	.096
	Zscore(EMP_SERV)	.062	-.071	.074	.246
	Zscore(NURS)	.400	-.126	-.224	.213
	Zscore(DISABL)	-.011	.602	.561	.469
	Zscore(HOSP)	.034	-.462	-.214	-.364
	Zscore(POPCHA)	.123	-.445	-.308	-.368
	Zscore(URBAN)	.130	.580	.409	.766
	Zscore(FEMALE)	.075	.232	.184	.738
	Zscore(FEMHEAD)	-.144	.512	.299	.892
	Zscore(SOCSEC)	-.070	.583	.516	.344

Original Model		Zscore (OVER)	Zscore (UNEMP)	Zscore (NUM_HH)	Zscore (EARN_MR)
Correlation	Zscore(MEDRENT)	-.167	-.871	-.540	.733
	Zscore(M_AGE)	.252	-.765	-.880	.528
	Zscore(PCINC)	.077	-.864	-.683	.937
	Zscore(MEDOWN)	.088	-.825	-.748	.555
	Zscore(PHYS)	.191	.436	-.124	-.335
	Zscore(BIRTH)	.178	.658	.524	-.648
	Zscore(PER_AA)	.011	.635	.826	-.486
	Zscore(PER_NA)	.406	-.098	-.270	.016
	Zscore(PER_AS)	.144	-.131	-.116	.243
	Zscore(PER_HIS)	.141	.808	.495	-.491
	Zscore(PER_OT)	.266	.611	.273	-.314
	Zscore(LESSFIVE)	-.142	.768	.810	-.551
	Zscore(OVER)	1.000	-.004	-.231	.032
	Zscore(UNEMP)	-.004	1.000	.617	-.759

	Zscore(NUM_HH)	-.231	.617	1.000	-.437
	Zscore(EARN_MR)	.032	-.759	-.437	1.000
	Zscore(PER_POV)	.102	.930	.513	-.759
	Zscore(RENT_OC)	-.107	.528	.213	-.425
	Zscore(RURAL)	.014	-.645	-.724	.461
	Zscore(MOBILE)	.024	.248	.247	-.315
	Zscore(NO_DIPLO)	.058	.865	.769	-.770
	Zscore(HU_SQMI)	.248	.404	.286	-.512
	Zscore(LABOR)	-.429	-.731	-.398	.659
	Zscore(FE_LAB)	-.425	-.810	-.540	.581
	Zscore(EMP_EXT)	.300	.146	.040	.298
	Zscore(EMP_TRAN)	.006	.290	.327	-.531
	Zscore(EMP_SERV)	.270	.124	.001	-.351
	Zscore(NURS)	.094	.138	.343	-.122
	Zscore(DISABL)	.387	.650	.262	-.515
	Zscore(HOSP)	.081	-.528	-.498	.169
	Zscore(POPCHA)	-.053	-.559	-.374	.588
	Zscore(URBAN)	-.014	.645	.724	-.461
	Zscore(FEMALE)	.316	.445	.593	-.337
	Zscore(FEMHEAD)	-.008	.793	.781	-.665
	Zscore(SOCSEC)	.711	.483	.370	-.402

Original Model		Zscore (PER_POV)	Zscore (RENT_OC)	Zscore (RURAL)	Zscore (MOBILE)
Correlation	Zscore(MEDRENT)	-.936	-.425	.455	-.364
	Zscore(M_AGE)	-.728	-.554	.766	-.135
	Zscore(PCINC)	-.829	-.482	.639	-.312
	Zscore(MEDOWN)	-.713	-.353	.639	-.249
	Zscore(PHYS)	.369	.628	-.282	-.198
	Zscore(BIRTH)	.783	.523	-.512	.139
	Zscore(PER_AA)	.551	.445	-.771	.024
	Zscore(PER_NA)	.046	-.235	.272	.266
	Zscore(PER_AS)	-.172	-.027	-.130	-.145
	Zscore(PER_HIS)	.713	.258	-.580	.413

	Zscore(PER_OT)	.541	.061	-.409	.442
	Zscore(LESSFIVE)	.763	.598	-.766	.059
	Zscore(OVER)	.102	-.107	.014	.024
	Zscore(UNEMP)	.930	.528	-.645	.248
	Zscore(NUM_HH)	.513	.213	-.724	.247
	Zscore(EARN_MR)	-.759	-.425	.461	-.315
	Zscore(PER_POV)	1.000	.575	-.501	.269
	Zscore(RENT_OC)	.575	1.000	-.494	-.168
	Zscore(RURAL)	-.501	-.494	1.000	-.029
	Zscore(MOBILE)	.269	-.168	-.029	1.000
	Zscore(NO_DIPLO)	.839	.547	-.803	.316
	Zscore(HU_SQMI)	.364	.658	-.522	-.197
	Zscore(LABOR)	-.790	-.146	.321	-.345
	Zscore(FE_LAB)	-.838	-.206	.464	-.385
	Zscore(EMP_EXT)	.142	.119	-.073	-.011
	Zscore(EMP_TRAN)	.225	-.176	-.270	.472
	Zscore(EMP_SERV)	.327	.385	-.069	.178
	Zscore(NURS)	.054	.355	-.336	-.097
	Zscore(DISABL)	.727	.331	-.265	.325
	Zscore(HOSP)	-.305	-.155	.513	.099
	Zscore(POPCHA)	-.490	-.387	.487	-.054
	Zscore(URBAN)	.501	.494	-1.000	.029
	Zscore(FEMALE)	.538	.363	-.482	.010
	Zscore(FEMHEAD)	.803	.572	-.679	.072
	Zscore(SOCSEC)	.508	-.038	-.398	.216

Original Model		Zscore (NO_DIPLO)	Zscore (HU_SQMI)	Zscore (LABOR)	Zscore (FE_LAB)
Correlation	Zscore(MEDRENT)	-.808	-.255	.860	.885
	Zscore(M_AGE)	-.848	-.378	.409	.569
	Zscore(PCINC)	-.907	-.515	.689	.689

	Zscore(MEDOWN)	-.780	-.366	.480	.662
	Zscore(PHYS)	.344	.570	-.175	-.217
	Zscore(BIRTH)	.756	.427	-.702	-.670
	Zscore(PER_AA)	.803	.568	-.399	-.532
	Zscore(PER_NA)	-.086	-.258	-.410	-.286
	Zscore(PER_AS)	-.154	-.172	.005	.044
	Zscore(PER_HIS)	.722	.178	-.656	-.795
	Zscore(PER_OT)	.522	-.057	-.639	-.727
	Zscore(LESSFIVE)	.861	.401	-.458	-.596
	Zscore(OVER)	.058	.248	-.429	-.425
	Zscore(UNEMP)	.865	.404	-.731	-.810
	Zscore(NUM_HH)	.769	.286	-.398	-.540
	Zscore(EARN_MR)	-.770	-.512	.659	.581
	Zscore(PER_POV)	.839	.364	-.790	-.838
	Zscore(RENT_OC)	.547	.658	-.146	-.206
	Zscore(RURAL)	-.803	-.522	.321	.464
	Zscore(MOBILE)	.316	-.197	-.345	-.385
	Zscore(NO_DIPLO)	1.000	.542	-.653	-.757
	Zscore(HU_SQMI)	.542	1.000	-.281	-.284
	Zscore(LABOR)	-.653	-.281	1.000	.941
	Zscore(FE_LAB)	-.757	-.284	.941	1.000
	Zscore(EMP_EXT)	.110	.119	-.058	-.282
	Zscore(EMP_TRAN)	.408	.040	-.443	-.332
	Zscore(EMP_SERV)	.350	.270	-.239	-.194
	Zscore(NURS)	.211	.508	-.043	-.060
	Zscore(DISABL)	.608	.281	-.709	-.780
	Zscore(HOSP)	-.368	-.312	.287	.384
	Zscore(POPCHA)	-.571	-.500	.509	.451
	Zscore(URBAN)	.803	.522	-.321	-.464
	Zscore(FEMALE)	.623	.422	-.518	-.586
	Zscore(FEMHEAD)	.853	.559	-.635	-.696
	Zscore(SOCSEC)	.538	.359	-.757	-.798

Original Model		Zscore (EMP_EXT)	Zscore (EMP_TRAN)	Zscore (EMP_SERV)	Zscore (NURS)
Correlation	Zscore(MEDRENT)	-.048	-.326	-.386	-.074
	Zscore(M_AGE)	-.121	-.083	-.153	-.241
	Zscore(PCINC)	.188	-.469	-.338	-.227
	Zscore(MEDOWN)	-.321	-.169	.170	-.129
	Zscore(PHYS)	.371	-.054	.277	-.011
	Zscore(BIRTH)	-.109	.241	.596	.181
	Zscore(PER_AA)	.083	.086	.263	.420
	Zscore(PER_NA)	-.075	.202	.447	-.222
	Zscore(PER_AS)	-.353	-.109	.062	.400
	Zscore(PER_HIS)	.395	.345	-.071	-.126
	Zscore(PER_OT)	.279	.335	.074	-.224
	Zscore(LESSFIVE)	.115	.096	.246	.213
	Zscore(OVER)	.300	.006	.270	.094
	Zscore(UNEMP)	.146	.290	.124	.138
	Zscore(NUM_HH)	.040	.327	.001	.343
	Zscore(EARN_MR)	.298	-.531	-.351	-.122
	Zscore(PER_POV)	.142	.225	.327	.054
	Zscore(RENT_OC)	.119	-.176	.385	.355
	Zscore(RURAL)	-.073	-.270	-.069	-.336
	Zscore(MOBILE)	-.011	.472	.178	-.097
	Zscore(NO_DIPLO)	.110	.408	.350	.211
	Zscore(HU_SQMI)	.119	.040	.270	.508
	Zscore(LABOR)	-.058	-.443	-.239	-.043
	Zscore(FE_LAB)	-.282	-.332	-.194	-.060
	Zscore(EMP_EXT)	1.000	-.304	-.170	-.281
	Zscore(EMP_TRAN)	-.304	1.000	.072	-.036
	Zscore(EMP_SERV)	-.170	.072	1.000	.076
	Zscore(NURS)	-.281	-.036	.076	1.000
	Zscore(DISABL)	.279	.029	.422	.024
	Zscore(HOSP)	-.294	-.106	.614	-.277
	Zscore(POPCHA)	.064	-.468	-.131	-.200
	Zscore(URBAN)	.073	.270	.069	.336

	Zscore(FEMALE)	.085	-.047	.543	.340
	Zscore(FEMHEAD)	.027	.142	.321	.330
	Zscore(SOCSEC)	.216	.284	.080	.133

Original Model		Zscore (DISABL)	Zscore (HOSP)	Zscore (POPCHA)	Zscore (URBAN)
Correlation	Zscore(MEDRENT)	-.793	.219	.525	-.455
	Zscore(M_AGE)	-.410	.422	.366	-.766
	Zscore(PCINC)	-.567	.302	.567	-.639
	Zscore(MEDOWN)	-.440	.650	.309	-.639
	Zscore(PHYS)	.360	-.089	-.321	.282
	Zscore(BIRTH)	.501	-.050	-.383	.512
	Zscore(PER_AA)	.432	-.433	-.316	.771
	Zscore(PER_NA)	.448	.401	-.114	-.272
	Zscore(PER_AS)	-.011	.034	.123	.130
	Zscore(PER_HIS)	.602	-.462	-.445	.580
	Zscore(PER_OT)	.561	-.214	-.308	.409
	Zscore(LESSFIVE)	.469	-.364	-.368	.766
	Zscore(OVER)	.387	.081	-.053	-.014
	Zscore(UNEMP)	.650	-.528	-.559	.645
	Zscore(NUM_HH)	.262	-.498	-.374	.724
	Zscore(EARN_MR)	-.515	.169	.588	-.461
	Zscore(PER_POV)	.727	-.305	-.490	.501
	Zscore(RENT_OC)	.331	-.155	-.387	.494
	Zscore(RURAL)	-.265	.513	.487	-1.000
	Zscore(MOBILE)	.325	.099	-.054	.029
	Zscore(NO_DIPLO)	.608	-.368	-.571	.803
	Zscore(HU_SQMI)	.281	-.312	-.500	.522
	Zscore(LABOR)	-.709	.287	.509	-.321
	Zscore(FE_LAB)	-.780	.384	.451	-.464
	Zscore(EMP_EXT)	.279	-.294	.064	.073
	Zscore(EMP_TRAN)	.029	-.106	-.468	.270
	Zscore(EMP_SERV)	.422	.614	-.131	.069
	Zscore(NURS)	.024	-.277	-.200	.336

	Zscore(DISABL)	1.000	-.120	-.366	.265
	Zscore(HOSP)	-.120	1.000	.353	-.513
	Zscore(POPCHA)	-.366	.353	1.000	-.487
	Zscore(URBAN)	.265	-.513	-.487	1.000
	Zscore(FEMALE)	.563	-.070	-.249	.482
	Zscore(FEMHEAD)	.558	-.379	-.598	.679
	Zscore(SOCSEC)	.496	-.281	-.306	.398

Original Model		Zscore (FEMALE)	Zscore (FEMHEAD)	Zscore (SOCSEC)
Correlation	Zscore(MEDRENT)	-.630	-.796	-.543
	Zscore(M_AGE)	-.657	-.892	-.311
	Zscore(PCINC)	-.539	-.829	-.446
	Zscore(MEDOWN)	-.361	-.694	-.507
	Zscore(PHYS)	.102	.198	.073
	Zscore(BIRTH)	.803	.819	.466
	Zscore(PER_AA)	.809	.838	.410
	Zscore(PER_NA)	.170	-.083	.128
	Zscore(PER_AS)	.075	-.144	-.070
	Zscore(PER_HIS)	.232	.512	.583
	Zscore(PER_OT)	.184	.299	.516
	Zscore(LESSFIVE)	.738	.892	.344
	Zscore(OVER)	.316	-.008	.711
	Zscore(UNEMP)	.445	.793	.483
	Zscore(NUM_HH)	.593	.781	.370
	Zscore(EARN_MR)	-.337	-.665	-.402
	Zscore(PER_POV)	.538	.803	.508
	Zscore(RENT_OC)	.363	.572	-.038
	Zscore(RURAL)	-.482	-.679	-.398
	Zscore(MOBILE)	.010	.072	.216
	Zscore(NO_DIPLO)	.623	.853	.538
	Zscore(HU_SQMI)	.422	.559	.359
	Zscore(LABOR)	-.518	-.635	-.757
	Zscore(FE_LAB)	-.586	-.696	-.798

	Zscore(EMP_EXT)	.085	.027	.216
	Zscore(EMP_TRAN)	-.047	.142	.284
	Zscore(EMP_SERV)	.543	.321	.080
	Zscore(NURS)	.340	.330	.133
	Zscore(DISABL)	.563	.558	.496
	Zscore(HOSP)	-.070	-.379	-.281
	Zscore(POPCHA)	-.249	-.598	-.306
	Zscore(URBAN)	.482	.679	.398
	Zscore(FEMALE)	1.000	.787	.478
	Zscore(FEMHEAD)	.787	1.000	.473
	Zscore(SOCSEC)	.478	.473	1.000

Correlation Matrix of Z-Scores for 48 Adjusted Data Variables

Adjusted Model		Zscore (PRIM)	Zscore (ELEC)	Zscore (COOKALT)	Zscore (NOCAR)	Zscore (NOWATER)
Correlation	Zscore(PRIM)	1.000	.147	-.144	.454	-.713
	Zscore(ELEC)	.147	1.000	-.998	-.099	-.020
	Zscore(COOKALT)	-.144	-.998	1.000	.069	.039
	Zscore(NOCAR)	.454	-.099	.069	1.000	-.786
	Zscore(NOWATER)	-.713	-.020	.039	-.786	1.000
	Zscore(FOREIGN)	.613	.306	-.298	.286	-.582
	Zscore(NOCIT)	.404	.200	-.200	.531	-.563
	Zscore(CARIB)	.654	.019	-.026	.184	-.537
	Zscore(NOENG)	.578	-.253	.244	.519	-.808
	Zscore(PUBASSIST)	.849	.016	-.035	.639	-.787
	Zscore(RECHOME)	-.793	-.273	.261	-.308	.626
	Zscore(BOATS)	-.651	-.296	.283	.032	.453
	Zscore(YRBLT)	.334	.389	-.399	.539	-.606
	Zscore(M_AGE)	-.963	-.092	.085	-.440	.693
	Zscore(PCINC)	-.769	.165	-.151	-.721	.824

	Zscore(MEDOWN)	-.847	-.115	.106	-.406	.726
	Zscore(MEDRENT)	-.723	.103	-.076	-.594	.774
	Zscore(PHYS)	.085	-.038	.009	.570	-.558
	Zscore(BIRTH)	.690	-.104	.067	.628	-.642
	Zscore(PER_AA)	.792	.146	-.148	.345	-.620
	Zscore(PER_AS)	-.174	.174	-.195	-.317	.151
	Zscore(PER_HIS)	.635	-.069	.065	.322	-.744
	Zscore(PER_OT)	.378	-.201	.186	.102	-.517
	Zscore(LESSFIVE)	.933	.086	-.090	.488	-.713
	Zscore(OVER)	-.228	-.098	.061	-.024	-.125
	Zscore(UNEMP)	.822	.052	-.067	.651	-.878
	Zscore(NUM_HH)	.856	.167	-.150	.187	-.494
	Zscore(EARN_MR)	-.554	.296	-.278	-.800	.765
	Zscore(PER_POV)	.781	-.092	.066	.720	-.839
	Zscore(RENT_OC)	.475	.124	-.148	.771	-.713
	Zscore(RURAL)	-.703	-.128	.124	-.312	.681
	Zscore(NO_DIPLO)	.824	-.131	.121	.617	-.853
	Zscore(HU_SQMI)	.313	.130	-.150	.661	-.680
	Zscore(LABOR)	-.519	.064	-.028	-.459	.658
	Zscore(FE_LAB)	-.645	.041	-.015	-.381	.710
	Zscore(EMP_EXT)	.092	.173	-.171	-.111	-.135
	Zscore(EMP_TRAN)	.140	-.169	.165	.217	-.227
	Zscore(EMP_SERV)	.049	-.555	.522	.417	-.219
	Zscore(DISABL)	.406	-.213	.190	.386	-.638
	Zscore(HOSP)	-.511	-.694	.683	-.110	.448
	Zscore(URBAN)	.703	.128	-.124	.312	-.681
	Zscore(FEMALE)	.592	.048	-.069	.275	-.448
	Zscore(FEMHEAD)	.887	.108	-.116	.605	-.794
	Zscore(SOCSEC)	.390	-.106	.085	.185	-.517

Adjusted Model		Zscore (FOREIGN)	Zscore (NOCIT)	Zscore (CARIB)	Zscore (NOENG)	Zscore (PUBASSIST)
Correlation	Zscore(PRIM)	.613	.404	.654	.578	.849
	Zscore(ELEC)	.306	.200	.019	-.253	.016

Zscore(COOKALT)	-.298	-.200	-.026	.244	-.035
Zscore(NOCAR)	.286	.531	.184	.519	.639
Zscore(NOWATER)	-.582	-.563	-.537	-.808	-.787
Zscore(FOREIGN)	1.000	.839	.675	.479	.379
Zscore(NOCIT)	.839	1.000	.360	.408	.226
Zscore(CARIB)	.675	.360	1.000	.497	.543
Zscore(NOENG)	.479	.408	.497	1.000	.689
Zscore(PUBASSIST)	.379	.226	.543	.689	1.000
Zscore(RECHOME)	-.639	-.460	-.524	-.414	-.549
Zscore(BOATS)	-.668	-.355	-.832	-.383	-.413
Zscore(YRBLT)	.531	.604	.297	.286	.321
Zscore(M_AGE)	-.680	-.497	-.726	-.550	-.777
Zscore(PCINC)	-.559	-.456	-.584	-.697	-.821
Zscore(MEDOWN)	-.617	-.432	-.506	-.628	-.676
Zscore(MEDRENT)	-.343	-.170	-.607	-.693	-.912
Zscore(PHYS)	.270	.538	.213	.531	.182
Zscore(BIRTH)	.358	.252	.683	.456	.823
Zscore(PER_AA)	.804	.566	.886	.428	.575
Zscore(PER_AS)	.069	-.011	.053	-.123	-.127
Zscore(PER_HIS)	.398	.189	.485	.882	.693
Zscore(PER_OT)	.205	-.021	.439	.752	.518
Zscore(LESSFIVE)	.681	.516	.772	.561	.803
Zscore(OVER)	-.082	-.190	.194	.061	-.010
Zscore(UNEMP)	.546	.441	.541	.822	.893
Zscore(NUM_HH)	.695	.350	.706	.412	.622
Zscore(EARN_MR)	-.364	-.376	-.334	-.642	-.721
Zscore(PER_POV)	.377	.315	.512	.745	.941
Zscore(RENT_OC)	.489	.743	.338	.441	.478
Zscore(RURAL)	-.858	-.679	-.683	-.620	-.549
Zscore(NO_DIPLO)	.716	.552	.748	.795	.820
Zscore(HU_SQMI)	.541	.641	.401	.324	.278
Zscore(LABOR)	-.159	.090	-.475	-.593	-.798
Zscore(FE_LAB)	-.315	-.022	-.614	-.688	-.814

	Zscore(EMP_EXT)	.114	.050	.234	.241	.021
	Zscore(EMP_TRAN)	.230	.047	.114	.375	.303
	Zscore(EMP_SERV)	.046	.157	.429	.199	.220
	Zscore(DISABL)	.242	.096	.583	.651	.606
	Zscore(HOSP)	-.606	-.391	-.245	-.325	-.372
	Zscore(URBAN)	.858	.679	.683	.620	.549
	Zscore(FEMALE)	.443	.201	.863	.217	.564
	Zscore(FEMHEAD)	.591	.413	.748	.533	.850
	Zscore(SOCSEC)	.205	-.084	.436	.415	.483

Adjusted Model		Zscore (RECHOME)	Zscore (BOATS)	Zscore (YRBLT)	Zscore (M_AGE)	Zscore (PCINC)
Correlation	Zscore(PRIM)	-.793	-.651	.334	-.963	-.769
	Zscore(ELEC)	-.273	-.296	.389	-.092	.165
	Zscore(COOKALT)	.261	.283	-.399	.085	-.151
	Zscore(NOCAR)	-.308	.032	.539	-.440	-.721
	Zscore(NOWATER)	.626	.453	-.606	.693	.824
	Zscore(FOREIGN)	-.639	-.668	.531	-.680	-.559
	Zscore(NOCIT)	-.460	-.355	.604	-.497	-.456
	Zscore(CARIB)	-.524	-.832	.297	-.726	-.584
	Zscore(NOENG)	-.414	-.383	.286	-.550	-.697
	Zscore(PUBASSIST)	-.549	-.413	.321	-.777	-.821
	Zscore(RECHOME)	1.000	.663	-.464	.818	.631
	Zscore(BOATS)	.663	1.000	-.321	.734	.320
	Zscore(YRBLT)	-.464	-.321	1.000	-.351	-.401
	Zscore(M_AGE)	.818	.734	-.351	1.000	.759
	Zscore(PCINC)	.631	.320	-.401	.759	1.000
	Zscore(MEDOWN)	.876	.568	-.403	.812	.715
	Zscore(MEDRENT)	.456	.415	-.232	.678	.826
	Zscore(PHYS)	-.175	-.130	.542	-.133	-.309
	Zscore(BIRTH)	-.375	-.368	.329	-.682	-.755
	Zscore(PER_AA)	-.758	-.760	.498	-.851	-.725
	Zscore(PER_AS)	.155	-.099	-.101	.157	.162
	Zscore(PER_HIS)	-.567	-.501	.226	-.576	-.602

	Zscore(PER_OT)	-.300	-.396	.004	-.323	-.418
	Zscore(LESSFIVE)	-.753	-.717	.373	-.969	-.770
	Zscore(OVER)	.219	-.060	.270	.252	.077
	Zscore(UNEMP)	-.661	-.448	.474	-.765	-.864
	Zscore(NUM_HH)	-.772	-.698	.282	-.880	-.683
	Zscore(EARN_MR)	.428	.016	-.374	.528	.937
	Zscore(PER_POV)	-.512	-.362	.352	-.728	-.829
	Zscore(RENT_OC)	-.391	-.340	.525	-.554	-.482
	Zscore(RURAL)	.688	.688	-.551	.766	.639
	Zscore(NO_DIPLO)	-.669	-.572	.450	-.848	-.907
	Zscore(HU_SQMI)	-.443	-.286	.814	-.378	-.515
	Zscore(LABOR)	.312	.234	-.261	.409	.689
	Zscore(FE_LAB)	.473	.473	-.292	.569	.689
	Zscore(EMP_EXT)	-.208	-.459	.175	-.121	.188
	Zscore(EMP_TRAN)	-.007	.180	-.018	-.083	-.469
	Zscore(EMP_SERV)	.249	-.032	.002	-.153	-.338
	Zscore(DISABL)	-.260	-.430	.158	-.410	-.567
	Zscore(HOSP)	.663	.453	-.527	.422	.302
	Zscore(URBAN)	-.688	-.688	.551	-.766	-.639
	Zscore(FEMALE)	-.419	-.673	.344	-.657	-.539
	Zscore(FEMHEAD)	-.677	-.639	.522	-.892	-.829
	Zscore(SOCSEC)	-.348	-.321	.382	-.311	-.446

Adjusted Model		Zscore (MEDOWN)	Zscore (MEDRENT)	Zscore (PHYS)	Zscore (BIRTH)	Zscore (PER_AA)
Correlation	Zscore(PRIM)	-.847	-.723	.085	.690	.792
	Zscore(ELEC)	-.115	.103	-.038	-.104	.146
	Zscore(COOKALT)	.106	-.076	.009	.067	-.148
	Zscore(NOCAR)	-.406	-.594	.570	.628	.345
	Zscore(NOWATER)	.726	.774	-.558	-.642	-.620
	Zscore(FOREIGN)	-.617	-.343	.270	.358	.804
	Zscore(NOCIT)	-.432	-.170	.538	.252	.566
	Zscore(CARIB)	-.506	-.607	.213	.683	.886
	Zscore(NOENG)	-.628	-.693	.531	.456	.428

Zscore(PUBASSIST)	-.676	-.912	.182	.823	.575
Zscore(RECHOME)	.876	.456	-.175	-.375	-.758
Zscore(BOATS)	.568	.415	-.130	-.368	-.760
Zscore(YRBLT)	-.403	-.232	.542	.329	.498
Zscore(M_AGE)	.812	.678	-.133	-.682	-.851
Zscore(PCINC)	.715	.826	-.309	-.755	-.725
Zscore(MEDOWN)	1.000	.628	-.222	-.409	-.693
Zscore(MEDRENT)	.628	1.000	-.279	-.788	-.562
Zscore(PHYS)	-.222	-.279	1.000	.218	.205
Zscore(BIRTH)	-.409	-.788	.218	1.000	.675
Zscore(PER_AA)	-.693	-.562	.205	.675	1.000
Zscore(PER_AS)	.353	.047	-.116	-.004	-.033
Zscore(PER_HIS)	-.761	-.712	.379	.387	.413
Zscore(PER_OT)	-.456	-.642	.323	.319	.233
Zscore(LESSFIVE)	-.755	-.728	.225	.772	.864
Zscore(OVER)	.088	-.167	.191	.178	.011
Zscore(UNEMP)	-.825	-.871	.436	.658	.635
Zscore(NUM_HH)	-.748	-.540	-.124	.524	.826
Zscore(EARN_MR)	.555	.733	-.335	-.648	-.486
Zscore(PER_POV)	-.713	-.936	.369	.783	.551
Zscore(RENT_OC)	-.353	-.425	.628	.523	.445
Zscore(RURAL)	.639	.455	-.282	-.512	-.771
Zscore(NO_DIPLO)	-.780	-.808	.344	.756	.803
Zscore(HU_SQMI)	-.366	-.255	.570	.427	.568
Zscore(LABOR)	.480	.860	-.175	-.702	-.399
Zscore(FE_LAB)	.662	.885	-.217	-.670	-.532
Zscore(EMP_EXT)	-.321	-.048	.371	-.109	.083
Zscore(EMP_TRAN)	-.169	-.326	-.054	.241	.086
Zscore(EMP_SERV)	.170	-.386	.277	.596	.263
Zscore(DISABL)	-.440	-.793	.360	.501	.432
Zscore(HOSP)	.650	.219	-.089	-.050	-.433
Zscore(URBAN)	-.639	-.455	.282	.512	.771
Zscore(FEMALE)	-.361	-.630	.102	.803	.809

	Zscore(FEMHEAD)	-.694	-.796	.198	.819	.838
	Zscore(SOCSEC)	-.507	-.543	.073	.466	.410

Adjusted Model		Zscore (PER_AS)	Zscore (PER_HIS)	Zscore (PER_OT)	Zscore (LESSFIVE)	Zscore (OVER)
Correlation	Zscore(PRIM)	-.174	.635	.378	.933	-.228
	Zscore(ELEC)	.174	-.069	-.201	.086	-.098
	Zscore(COOKALT)	-.195	.065	.186	-.090	.061
	Zscore(NOCAR)	-.317	.322	.102	.488	-.024
	Zscore(NOWATER)	.151	-.744	-.517	-.713	-.125
	Zscore(FOREIGN)	.069	.398	.205	.681	-.082
	Zscore(NOCIT)	-.011	.189	-.021	.516	-.190
	Zscore(CARIB)	.053	.485	.439	.772	.194
	Zscore(NOENG)	-.123	.882	.752	.561	.061
	Zscore(PUBASSIST)	-.127	.693	.518	.803	-.010
	Zscore(RECHOME)	.155	-.567	-.300	-.753	.219
	Zscore(BOATS)	-.099	-.501	-.396	-.717	-.060
	Zscore(YRBLT)	-.101	.226	.004	.373	.270
	Zscore(M_AGE)	.157	-.576	-.323	-.969	.252
	Zscore(PCINC)	.162	-.602	-.418	-.770	.077
	Zscore(MEDOWN)	.353	-.761	-.456	-.755	.088
	Zscore(MEDRENT)	.047	-.712	-.642	-.728	-.167
	Zscore(PHYS)	-.116	.379	.323	.225	.191
	Zscore(BIRTH)	-.004	.387	.319	.772	.178
	Zscore(PER_AA)	-.033	.413	.233	.864	.011
	Zscore(PER_AS)	1.000	-.159	.179	-.124	.144
	Zscore(PER_HIS)	-.159	1.000	.858	.572	.141
	Zscore(PER_OT)	.179	.858	1.000	.333	.266
	Zscore(LESSFIVE)	-.124	.572	.333	1.000	-.142
	Zscore(OVER)	.144	.141	.266	-.142	1.000
	Zscore(UNEMP)	-.131	.808	.611	.768	-.004
	Zscore(NUM_HH)	-.116	.495	.273	.810	-.231
	Zscore(EARN_MR)	.243	-.491	-.314	-.551	.032
	Zscore(PER_POV)	-.172	.713	.541	.763	.102

	Zscore(RENT_OC)	-.027	.258	.061	.598	-.107
	Zscore(RURAL)	-.130	-.580	-.409	-.766	.014
	Zscore(NO_DIPLO)	-.154	.722	.522	.861	.058
	Zscore(HU_SQMI)	-.172	.178	-.057	.401	.248
	Zscore(LABOR)	.005	-.656	-.639	-.458	-.429
	Zscore(FE_LAB)	.044	-.795	-.727	-.596	-.425
	Zscore(EMP_EXT)	-.353	.395	.279	.115	.300
	Zscore(EMP_TRAN)	-.109	.345	.335	.096	.006
	Zscore(EMP_SERV)	.062	-.071	.074	.246	.270
	Zscore(DISABL)	-.011	.602	.561	.469	.387
	Zscore(HOSP)	.034	-.462	-.214	-.364	.081
	Zscore(URBAN)	.130	.580	.409	.766	-.014
	Zscore(FEMALE)	.075	.232	.184	.738	.316
	Zscore(FEMHEAD)	-.144	.512	.299	.892	-.008
	Zscore(SOCSEC)	-.070	.583	.516	.344	.711

Adjusted Model		Zscore (UNEMP)	Zscore (NUM_HH)	Zscore (EARN_MR)	Zscore (PER_POV)	Zscore (RENT_ OC)
Correlation	Zscore(PRIM)	.822	.856	-.554	.781	.475
	Zscore(ELEC)	.052	.167	.296	-.092	.124
	Zscore(COOKALT)	-.067	-.150	-.278	.066	-.148
	Zscore(NOCAR)	.651	.187	-.800	.720	.771
	Zscore(NOWATER)	-.878	-.494	.765	-.839	-.713
	Zscore(FOREIGN)	.546	.695	-.364	.377	.489
	Zscore(NOCIT)	.441	.350	-.376	.315	.743
	Zscore(CARIB)	.541	.706	-.334	.512	.338
	Zscore(NOENG)	.822	.412	-.642	.745	.441
	Zscore(PUBASSIST)	.893	.622	-.721	.941	.478
	Zscore(RECHOME)	-.661	-.772	.428	-.512	-.391
	Zscore(BOATS)	-.448	-.698	.016	-.362	-.340
	Zscore(YRBLT)	.474	.282	-.374	.352	.525
	Zscore(M_AGE)	-.765	-.880	.528	-.728	-.554
	Zscore(PCINC)	-.864	-.683	.937	-.829	-.482

	Zscore(MEDOWN)	-.825	-.748	.555	-.713	-.353
	Zscore(MEDRENT)	-.871	-.540	.733	-.936	-.425
	Zscore(PHYS)	.436	-.124	-.335	.369	.628
	Zscore(BIRTH)	.658	.524	-.648	.783	.523
	Zscore(PER_AA)	.635	.826	-.486	.551	.445
	Zscore(PER_AS)	-.131	-.116	.243	-.172	-.027
	Zscore(PER_HIS)	.808	.495	-.491	.713	.258
	Zscore(PER_OT)	.611	.273	-.314	.541	.061
	Zscore(LESSFIVE)	.768	.810	-.551	.763	.598
	Zscore(OVER)	-.004	-.231	.032	.102	-.107
	Zscore(UNEMP)	1.000	.617	-.759	.930	.528
	Zscore(NUM_HH)	.617	1.000	-.437	.513	.213
	Zscore(EARN_MR)	-.759	-.437	1.000	-.759	-.425
	Zscore(PER_POV)	.930	.513	-.759	1.000	.575
	Zscore(RENT_OC)	.528	.213	-.425	.575	1.000
	Zscore(RURAL)	-.645	-.724	.461	-.501	-.494
	Zscore(NO_DIPLO)	.865	.769	-.770	.839	.547
	Zscore(HU_SQMI)	.404	.286	-.512	.364	.658
	Zscore(LABOR)	-.731	-.398	.659	-.790	-.146
	Zscore(FE_LAB)	-.810	-.540	.581	-.838	-.206
	Zscore(EMP_EXT)	.146	.040	.298	.142	.119
	Zscore(EMP_TRAN)	.290	.327	-.531	.225	-.176
	Zscore(EMP_SERV)	.124	.001	-.351	.327	.385
	Zscore(DISABL)	.650	.262	-.515	.727	.331
	Zscore(HOSP)	-.528	-.498	.169	-.305	-.155
	Zscore(URBAN)	.645	.724	-.461	.501	.494
	Zscore(FEMALE)	.445	.593	-.337	.538	.363
	Zscore(FEMHEAD)	.793	.781	-.665	.803	.572
	Zscore(SOCSEC)	.483	.370	-.402	.508	-.038

Adjusted Model		Zscore (RURAL)	Zscore (NO_DIPLO)	Zscore (HU_SQMI)	Zscore (LABOR)	Zscore (FE_LAB)
Correlation	Zscore(PRIM)	-.703	.824	.313	-.519	-.645
	Zscore(ELEC)	-.128	-.131	.130	.064	.041

Zscore(COOKALT)	.124	.121	-.150	-.028	-.015
Zscore(NOCAR)	-.312	.617	.661	-.459	-.381
Zscore(NOWATER)	.681	-.853	-.680	.658	.710
Zscore(FOREIGN)	-.858	.716	.541	-.159	-.315
Zscore(NOCIT)	-.679	.552	.641	.090	-.022
Zscore(CARIB)	-.683	.748	.401	-.475	-.614
Zscore(NOENG)	-.620	.795	.324	-.593	-.688
Zscore(PUBASSIST)	-.549	.820	.278	-.798	-.814
Zscore(RECHOME)	.688	-.669	-.443	.312	.473
Zscore(BOATS)	.688	-.572	-.286	.234	.473
Zscore(YRBLT)	-.551	.450	.814	-.261	-.292
Zscore(M_AGE)	.766	-.848	-.378	.409	.569
Zscore(PCINC)	.639	-.907	-.515	.689	.689
Zscore(MEDOWN)	.639	-.780	-.366	.480	.662
Zscore(MEDRENT)	.455	-.808	-.255	.860	.885
Zscore(PHYS)	-.282	.344	.570	-.175	-.217
Zscore(BIRTH)	-.512	.756	.427	-.702	-.670
Zscore(PER_AA)	-.771	.803	.568	-.399	-.532
Zscore(PER_AS)	-.130	-.154	-.172	.005	.044
Zscore(PER_HIS)	-.580	.722	.178	-.656	-.795
Zscore(PER_OT)	-.409	.522	-.057	-.639	-.727
Zscore(LESSFIVE)	-.766	.861	.401	-.458	-.596
Zscore(OVER)	.014	.058	.248	-.429	-.425
Zscore(UNEMP)	-.645	.865	.404	-.731	-.810
Zscore(NUM_HH)	-.724	.769	.286	-.398	-.540
Zscore(EARN_MR)	.461	-.770	-.512	.659	.581
Zscore(PER_POV)	-.501	.839	.364	-.790	-.838
Zscore(RENT_OC)	-.494	.547	.658	-.146	-.206
Zscore(RURAL)	1.000	-.803	-.522	.321	.464
Zscore(NO_DIPLO)	-.803	1.000	.542	-.653	-.757
Zscore(HU_SQMI)	-.522	.542	1.000	-.281	-.284
Zscore(LABOR)	.321	-.653	-.281	1.000	.941
Zscore(FE_LAB)	.464	-.757	-.284	.941	1.000

	Zscore(EMP_EXT)	-.073	.110	.119	-.058	-.282
	Zscore(EMP_TRAN)	-.270	.408	.040	-.443	-.332
	Zscore(EMP_SERV)	-.069	.350	.270	-.239	-.194
	Zscore(DISABL)	-.265	.608	.281	-.709	-.780
	Zscore(HOSP)	.513	-.368	-.312	.287	.384
	Zscore(URBAN)	-1.000	.803	.522	-.321	-.464
	Zscore(FEMALE)	-.482	.623	.422	-.518	-.586
	Zscore(FEMHEAD)	-.679	.853	.559	-.635	-.696
	Zscore(SOCSEC)	-.398	.538	.359	-.757	-.798

Adjusted Model		Zscore (EMP_EXT)	Zscore (EMP_ TRAN)	Zscore (EMP_ SERV)	Zscore (DISABL)	Zscore (HOSP)
Correlation	Zscore(PRIM)	.092	.140	.049	.406	-.511
	Zscore(ELEC)	.173	-.169	-.555	-.213	-.694
	Zscore(COOKALT)	-.171	.165	.522	.190	.683
	Zscore(NOCAR)	-.111	.217	.417	.386	-.110
	Zscore(NOWATER)	-.135	-.227	-.219	-.638	.448
	Zscore(FOREIGN)	.114	.230	.046	.242	-.606
	Zscore(NOCIT)	.050	.047	.157	.096	-.391
	Zscore(CARIB)	.234	.114	.429	.583	-.245
	Zscore(NOENG)	.241	.375	.199	.651	-.325
	Zscore(PUBASSIST)	.021	.303	.220	.606	-.372
	Zscore(RECHOME)	-.208	-.007	.249	-.260	.663
	Zscore(BOATS)	-.459	.180	-.032	-.430	.453
	Zscore(YRBLT)	.175	-.018	.002	.158	-.527
	Zscore(M_AGE)	-.121	-.083	-.153	-.410	.422
	Zscore(PCINC)	.188	-.469	-.338	-.567	.302
	Zscore(MEDOWN)	-.321	-.169	.170	-.440	.650
	Zscore(MEDRENT)	-.048	-.326	-.386	-.793	.219
	Zscore(PHYS)	.371	-.054	.277	.360	-.089
	Zscore(BIRTH)	-.109	.241	.596	.501	-.050
	Zscore(PER_AA)	.083	.086	.263	.432	-.433
	Zscore(PER_AS)	-.353	-.109	.062	-.011	.034

	Zscore(PER_HIS)	.395	.345	-.071	.602	-.462
	Zscore(PER_OT)	.279	.335	.074	.561	-.214
	Zscore(LESSFIVE)	.115	.096	.246	.469	-.364
	Zscore(OVER)	.300	.006	.270	.387	.081
	Zscore(UNEMP)	.146	.290	.124	.650	-.528
	Zscore(NUM_HH)	.040	.327	.001	.262	-.498
	Zscore(EARN_MR)	.298	-.531	-.351	-.515	.169
	Zscore(PER_POV)	.142	.225	.327	.727	-.305
	Zscore(RENT_OC)	.119	-.176	.385	.331	-.155
	Zscore(RURAL)	-.073	-.270	-.069	-.265	.513
	Zscore(NO_DIPLO)	.110	.408	.350	.608	-.368
	Zscore(HU_SQMI)	.119	.040	.270	.281	-.312
	Zscore(LABOR)	-.058	-.443	-.239	-.709	.287
	Zscore(FE_LAB)	-.282	-.332	-.194	-.780	.384
	Zscore(EMP_EXT)	1.000	-.304	-.170	.279	-.294
	Zscore(EMP_TRAN)	-.304	1.000	.072	.029	-.106
	Zscore(EMP_SERV)	-.170	.072	1.000	.422	.614
	Zscore(DISABL)	.279	.029	.422	1.000	-.120
	Zscore(HOSP)	-.294	-.106	.614	-.120	1.000
	Zscore(URBAN)	.073	.270	.069	.265	-.513
	Zscore(FEMALE)	.085	-.047	.543	.563	-.070
	Zscore(FEMHEAD)	.027	.142	.321	.558	-.379
	Zscore(SOCSEC)	.216	.284	.080	.496	-.281

Adjusted Model		Zscore (URBAN)	Zscore (FEMALE)	Zscore (FEMHEAD)	Zscore (SOCSEC)
Correlation	Zscore(PRIM)	.703	.592	.887	.390
	Zscore(ELEC)	.128	.048	.108	-.106
	Zscore(COOKALT)	-.124	-.069	-.116	.085
	Zscore(NOCAR)	.312	.275	.605	.185
	Zscore(NOWATER)	-.681	-.448	-.794	-.517
	Zscore(FOREIGN)	.858	.443	.591	.205
	Zscore(NOCIT)	.679	.201	.413	-.084
	Zscore(CARIB)	.683	.863	.748	.436

Zscore(NOENG)	.620	.217	.533	.415
Zscore(PUBASSIST)	.549	.564	.850	.483
Zscore(RECHOME)	-.688	-.419	-.677	-.348
Zscore(BOATS)	-.688	-.673	-.639	-.321
Zscore(YRBLT)	.551	.344	.522	.382
Zscore(M_AGE)	-.766	-.657	-.892	-.311
Zscore(PCINC)	-.639	-.539	-.829	-.446
Zscore(MEDOWN)	-.639	-.361	-.694	-.507
Zscore(MEDRENT)	-.455	-.630	-.796	-.543
Zscore(PHYS)	.282	.102	.198	.073
Zscore(BIRTH)	.512	.803	.819	.466
Zscore(PER_AA)	.771	.809	.838	.410
Zscore(PER_AS)	.130	.075	-.144	-.070
Zscore(PER_HIS)	.580	.232	.512	.583
Zscore(PER_OT)	.409	.184	.299	.516
Zscore(LESSFIVE)	.766	.738	.892	.344
Zscore(OVER)	-.014	.316	-.008	.711
Zscore(UNEMP)	.645	.445	.793	.483
Zscore(NUM_HH)	.724	.593	.781	.370
Zscore(EARN_MR)	-.461	-.337	-.665	-.402
Zscore(PER_POV)	.501	.538	.803	.508
Zscore(RENT_OC)	.494	.363	.572	-.038
Zscore(RURAL)	-1.000	-.482	-.679	-.398
Zscore(NO_DIPLO)	.803	.623	.853	.538
Zscore(HU_SQMI)	.522	.422	.559	.359
Zscore(LABOR)	-.321	-.518	-.635	-.757
Zscore(FE_LAB)	-.464	-.586	-.696	-.798
Zscore(EMP_EXT)	.073	.085	.027	.216
Zscore(EMP_TRAN)	.270	-.047	.142	.284
Zscore(EMP_SERV)	.069	.543	.321	.080
Zscore(DISABL)	.265	.563	.558	.496
Zscore(HOSP)	-.513	-.070	-.379	-.281
Zscore(URBAN)	1.000	.482	.679	.398

	Zscore(FEMALE)	.482	1.000	.787	.478
	Zscore(FEMHEAD)	.679	.787	1.000	.473
	Zscore(SOCSEC)	.398	.478	.473	1.000

APPENDIX C

PRINCIPLE COMPONENTS ANALYSIS OUTPUT TABLES

Output Table Original Model: Eight components were generated by the PCA that accounted for 93.66% of the variance among 33 original variables in the dataset.

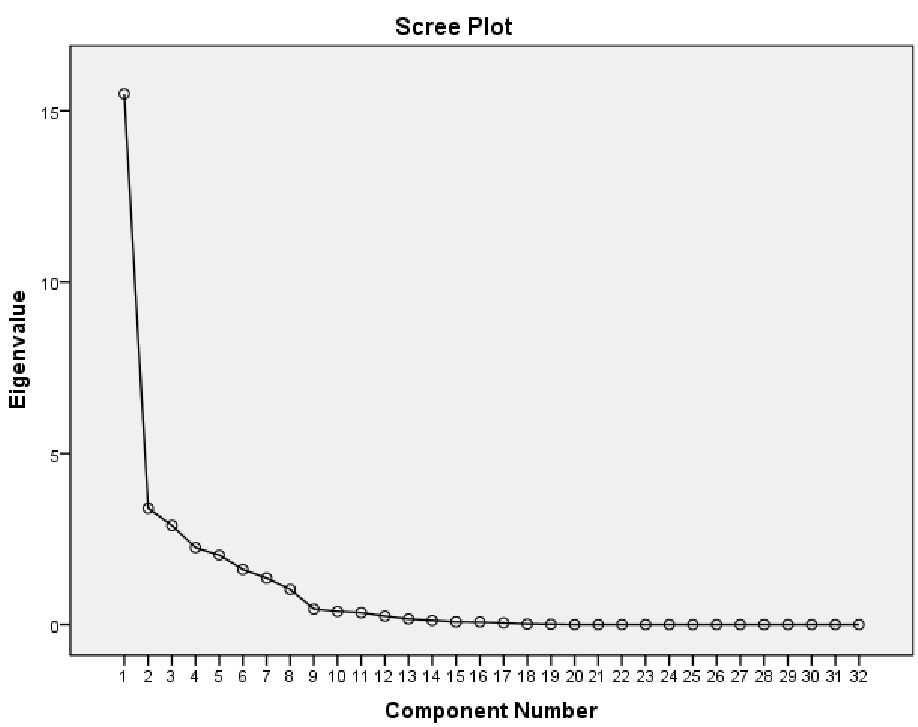
Total Variance Explained

Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
dimension0	1	15.493	48.416	48.416	15.493	48.416	48.416
	2	3.403	10.633	59.049	3.403	10.633	59.049
	3	2.902	9.068	68.116	2.902	9.068	68.116
	4	2.255	7.047	75.164	2.255	7.047	75.164
	5	2.032	6.350	81.514	2.032	6.350	81.514
	6	1.604	5.012	86.526	1.604	5.012	86.526
	7	1.356	4.236	90.762	1.356	4.236	90.762
	8	1.025	3.203	93.966	1.025	3.203	93.966
	9	.454	1.418	95.383			
	10	.383	1.197	96.580			
	11	.346	1.080	97.660			
	12	.244	.764	98.424			
	13	.162	.505	98.929			
	14	.117	.367	99.295			
	15	.078	.244	99.539			
	16	.073	.230	99.769			
	17	.048	.152	99.920			
	18	.016	.051	99.971			
	19	.009	.029	100.000			
	20	2.217E-15	6.928E-15	100.000			
	21	6.101E-16	1.907E-15	100.000			
	22	5.332E-16	1.666E-15	100.000			
	23	4.350E-16	1.359E-15	100.000			
	24	2.322E-16	7.256E-16	100.000			
	25	1.622E-16	5.068E-16	100.000			
	26	5.394E-17	1.686E-16	100.000			

27	-8.125E-17	-2.539E-16	100.000				
28	-9.429E-17	-2.947E-16	100.000				
29	-1.417E-16	-4.427E-16	100.000				
30	-3.012E-16	-9.414E-16	100.000				
31	-4.588E-16	-1.434E-15	100.000				
32	-8.084E-16	-2.526E-15	100.000				

Extraction Method: Principal Component Analysis.

Scree Plot for Original Model showing eight components that represent 93.966% of the variance among 33 original variables in the dataset.



Output Table Adjusted Model: Eight components were generated by the PCA that accounted for 93.419% of the variance among 46 adjusted variables in the dataset.

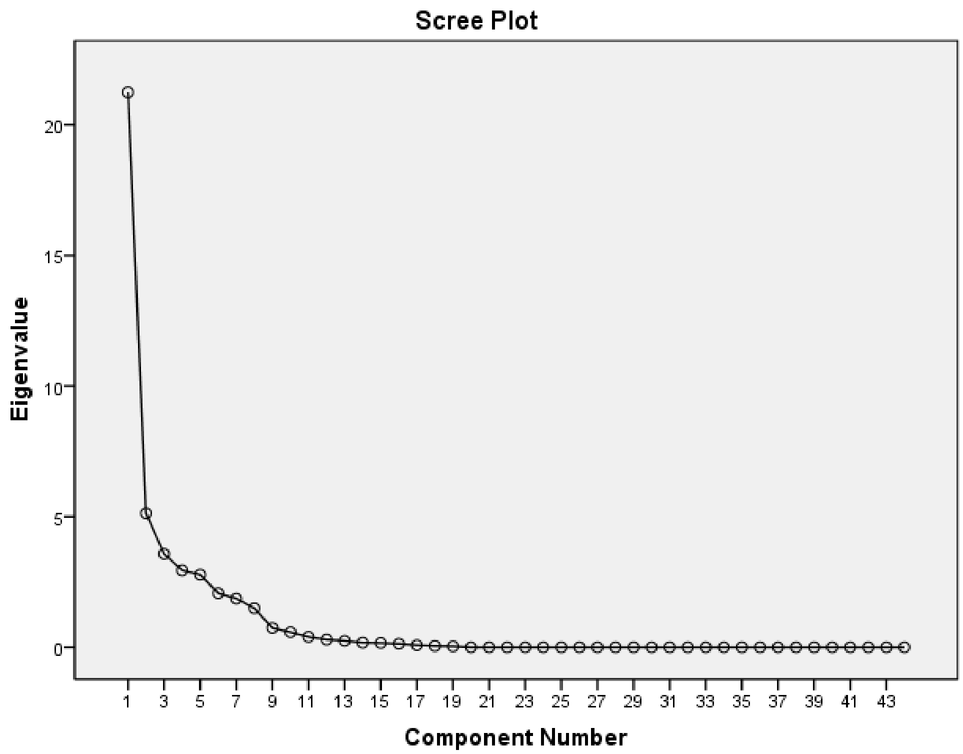
Total Variance Explained

Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
dimension0	1	21.247	48.288	48.288	21.247	48.288	48.288
	2	5.130	11.660	59.948	5.130	11.660	59.948
	3	3.574	8.124	68.072	3.574	8.124	68.072
	4	2.948	6.699	74.771	2.948	6.699	74.771
	5	2.780	6.318	81.089	2.780	6.318	81.089
	6	2.068	4.699	85.788	2.068	4.699	85.788
	7	1.863	4.235	90.024	1.863	4.235	90.024
	8	1.494	3.396	93.419	1.494	3.396	93.419
	9	.743	1.688	95.107			
	10	.575	1.307	96.415			
	11	.398	.904	97.318			
	12	.294	.669	97.988			
	13	.246	.558	98.546			
	14	.174	.396	98.942			
	15	.161	.366	99.309			
	16	.135	.308	99.616			
	17	.082	.187	99.803			
	18	.053	.120	99.923			
	19	.034	.077	100.000			
	20	3.422E-15	7.777E-15	100.000			
	21	1.045E-15	2.374E-15	100.000			
	22	8.163E-16	1.855E-15	100.000			
	23	7.400E-16	1.682E-15	100.000			
	24	6.308E-16	1.434E-15	100.000			
	25	5.635E-16	1.281E-15	100.000			
	26	4.199E-16	9.543E-16	100.000			
	27	3.715E-16	8.443E-16	100.000			
	28	3.075E-16	6.988E-16	100.000			

29	1.821 E-16	4.138E-16	100.000			
30	1.369 E-16	3.112E-16	100.000			
31	6.452 E-17	1.466E-16	100.000			
32	3.282 E-17	7.460E-17	100.000			
33	-3.936 E-17	-8.945E-17	100.000			
34	-1.199 E-16	-2.724E-16	100.000			
35	-1.313 E-16	-2.983E-16	100.000			
36	-2.009 E-16	-4.565E-16	100.000			
37	-2.300 E-16	-5.227E-16	100.000			
38	-3.848 E-16	-8.745E-16	100.000			
39	-4.153 E-16	-9.438E-16	100.000			
40	-4.947 E-16	-1.124E-15	100.000			
41	-6.511 E-16	-1.480E-15	100.000			
42	-8.879 E-16	-2.018E-15	100.000			
43	-1.258 E-15	-2.859E-15	100.000			
44	-2.608 E-15	-5.927E-15	100.000			

Extraction Method: Principal Component Analysis.

Scree Plot for Adjusted Model showing eight components that represent 93.419% of the variance among 46 adjusted variables in the dataset.



APPENDIX D

ROTATED COMPONENT MATRICES
ORIGINAL AND ADJUSTED MODELS

Rotated Component Matrix with Component Loadings for 33 Original Socio-Economic Data Variables.

	Component					
	1	2	3	4	5	6
Zscore(PER_AA)	.886					
Zscore(NUM_HH)	.883					
Zscore(M_AGE)	-.879					
Zscore(LESSFIVE)	.857					
Zscore(RURAL)	-.843					
Zscore(URBAN)	.843					
Zscore(FEMHEAD)	.740					
Zscore(NO_DIPLO)	.723					
Zscore(FEMALE)	.670					
Zscore(MEDOWN)	-.623					
Zscore(MEDRENT)		-.892				
Zscore(PER_POV)		.856				
Zscore(LABOR)		-.848				
Zscore(FE_LAB)		-.810				
Zscore(DISABL)		.787				
Zscore(UNEMP)		.765				
Zscore(PCINC)		-.655				
Zscore(EARN_MR)		-.649				
Zscore(PER_HIS)		.601				
Zscore(BIRTH)		.590				
Zscore(PHYS)			.903			
Zscore(RENT_OC)			.738			
Zscore(HU_SQMI)			.680			
Zscore(EMP_SERV)				.891		
Zscore(HOSP)				.838		
Zscore(OVER)					.924	
Zscore(SOCSEC)					.767	

Zscore(EMP_TRAN)						-.892
Zscore(EMP_EXT)						.545
Zscore(NURS)						
Zscore(PER_OT)		.563				
Zscore(PER_AS)						

	Component	
	7	8
Zscore(PER_AA)		
Zscore(NUM_HH)		
Zscore(M_AGE)		
Zscore(LESSFIVE)		
Zscore(RURAL)		
Zscore(URBAN)		
Zscore(FEMHEAD)		
Zscore(NO_DIPLO)		
Zscore(FEMALE)		
Zscore(MEDOWN)		
Zscore(MEDRENT)		
Zscore(PER_POV)		
Zscore(LABOR)		
Zscore(FE_LAB)		
Zscore(DISABL)		
Zscore(UNEMP)		
Zscore(PCINC)		
Zscore(EARN_MR)		
Zscore(PER_HIS)	.513	
Zscore(BIRTH)		
Zscore(PHYS)		
Zscore(RENT_OC)		
Zscore(HU_SQMI)		
Zscore(EMP_SERV)		
Zscore(HOSP)		
Zscore(OVER)		
Zscore(SOCSEC)		
Zscore(EMP_TRAN)		
Zscore(EMP_EXT)		

Zscore(NURS)	-.713	
Zscore(PER_OT)	.652	
Zscore(PER_AS)		.978

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Rotated Component Matrix with Component Loadings for 46 Adjusted Socio-Economic Data Variables.

	Component							
	1	2	3	4	5	6	7	8
Zscore(PER_AA)	.876							
Zscore(NUM_HH)	.861							
Zscore(BOATS)	-.824							
Zscore(M_AGE)	-.805							
Zscore(CARIB)	.802							
Zscore(RURAL)	-.797							
Zscore(URBAN)	.797							
Zscore(FOREIGN)	.794							
Zscore(LESSFIVE)	.771							
Zscore(PRIM)	.702							
Zscore(RECHOME)	-.699							
Zscore(NO_DIPLO)	.652							
Zscore(FEMALE)	.645							
Zscore(MEDOWN)	-.583							
Zscore(MEDRENT)		-.892						
Zscore(PUBASSIST)		.883						
Zscore(PER_POV)		.875						
Zscore(LABOR)		-.817						
Zscore(BIRTH)		.754						
Zscore(FE_LAB)		-.744						
Zscore(UNEMP)		.741						
Zscore(PCINC)		-.693						
Zscore(FEMHEAD)		.684						
Zscore(EARN_MR)		-.673						

Zscore(DISABL)		.650						
Zscore(NOWATER)		-.629	-.542					
Zscore(PHYS)			.800					
Zscore(HU_SQMI)			.790					
Zscore(NOCIT)			.778					
Zscore(RENT_OC)			.765					
Zscore(YRBLT)			.713					
Zscore(NOCAR)			.692					
Zscore(ELEC)				-.917				
Zscore(COOKALT)				.911				
Zscore(HOSP)				.814				
Zscore(EMP_SERV)				.769				
Zscore(PER_OT)					.798			
Zscore(PER_HIS)					.756			
Zscore(NOENG)					.693			
Zscore(OVER)						.929		
Zscore(SOCSEC)						.772		
Zscore(EMP_TRAN)							-.815	
Zscore(EMP_EXT)							.640	
Zscore(PER_AS)								.921

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX E

COMPONENT SCORES BY SUBDISTRICT
ORIGINAL AND ADJUSTED MODELS

Component Scores by Subdistrict for St. Croix, St. Thomas and St. John
For Computation in Original Social Vulnerability Index

Subdistrict Name	Component 1	Component 2	Component 3	Component 4	Component 5	Component 6	Component 7	Component 8
St. Croix								
Anna's Hope Village	0.16203	0.36354	0.66235	0.98526	0.71895	-0.77265	1.11939	0.88267
Christiansted	-0.41335	1.11565	3.4073	0.07	0.3759	0.38215	1.06285	-0.29182
East End	-1.03727	0.78598	0.43692	1.00349	2.15721	1.84399	0.86062	-0.62358
Frederiksted	0.93391	1.74196	0.02174	0.39745	-0.82328	0.56655	-0.32983	-0.57021
Northcentral	0.32895	0.84645	0.68687	0.25819	0.27567	-0.45006	0.98584	-0.47326
Northwest	0.59332	1.27783	0.85163	0.42918	-0.5968	0.61125	-0.2212	-0.48135
Sion Farm	0.32227	0.5264	0.21367	0.70164	0.51822	-0.08615	-0.39445	0.62769
Southcentral	0.67447	0.71574	0.41014	0.41444	-0.6128	-1.31845	1.57006	0.04574
Southwest	0.43069	1.07219	0.64265	0.46265	0.34066	-0.45271	0.48978	-0.19791
St. Thomas								
Charlotte Amalie	0.4254	0.05658	1.58867	0.0394	1.053	-0.23018	-1.95816	-0.28183
East End	0.68906	1.02415	0.27313	0.09986	-0.42657	-0.47856	0.15613	-0.5406
Northside	0.15737	1.42948	0.30095	0.76255	-0.22299	0.97053	0.63755	1.30691
Southside	0.59105	0.08702	0.27202	0.39624	-1.04705	0.55638	-1.27514	2.93857
Tutu	1.37366	0.70894	0.5217	0.02332	1.41531	-0.72518	-1.90988	-1.03645
Water Island	-2.33176	0.56696	0.21399	1.75585	-1.63629	-1.77132	-0.83984	-0.70996
West End	0.07831	0.69746	0.91164	0.56351	-0.79763	1.49805	-0.3489	-0.52608
St. John								
Central	-0.79145	0.25657	0.16148	1.29126	-1.42856	1.72416	0.06777	-0.60518
Coral Bay	-1.2145	0.02595	0.32677	0.9972	-0.19593	-0.10323	-0.53117	-0.97699
Cruz Bay	1.04953	2.17007	0.55513	2.05319	-0.41389	-0.99944	1.08702	-0.10763
East End	-2.02171	0.70243	0.76366	2.1684	1.34689	-0.76515	-0.22844	1.62129

Component Scores by Subdistrict for St. Croix, St. Thomas and St. John For Computation in Adjusted Social Vulnerability Index								
Subdistrict Name	**Component 1**	**Component 2**	**Component 3**	**Component 4**	**Component 5**	**Component 6**	**Component 7**	**Component 8**
St. Croix								
Anna's Hope Village	0.49643	0.84444	-0.86197	0.24189	1.29976	0.63321	-0.89332	0.18748
Christiansted	-0.64446	0.72027	2.85024	0.15199	1.76054	0.45576	1.04606	-0.1776
East End	-0.98714	1.01569	-0.69951	1.1902	0.6006	1.82093	1.8463	-0.61079
Frederiksted	0.31089	2.48124	0.09173	0.16685	-0.59423	-0.69466	0.52956	-0.45373
Northcentral	0.44951	0.44757	-0.70324	0.53868	1.12962	0.36049	-0.40973	-0.77642
Northwest	0.38686	1.58622	-0.3979	0.66886	-0.89594	-0.38152	0.47932	0.12181
Sion Farm	0.25697	0.50826	-0.32174	0.72989	0.25996	0.49455	-0.17897	0.25591
Southcentral	0.59129	0.75697	-0.94703	0.00226	1.54773	-0.83606	-0.85565	0.04263
Southwest	0.68505	0.51863	-0.72045	0.72768	1.20256	0.35928	-0.64262	-0.58683
St. Thomas								
Charlotte Amalie	0.5102	0.11534	2.09202	0.08355	-0.77922	0.95014	-0.35258	-0.34625
East End	0.83082	1.04912	0.52184	0.28361	-0.1018	-0.53057	-0.543	-0.01498
Northside	0.22627	1.42761	0.01198	0.89056	0.35002	-0.37198	0.72115	0.95753
Southside	0.59108	0.11688	0.51812	1.00986	-0.35482	-1.12849	0.01517	2.55172
Tutu	1.26875	0.19348	0.12812	0.74247	-2.111	1.61981	-0.92108	-0.96746
Water Island	-2.56906	0.54155	0.42158	1.5723	-0.1763	-1.51496	-1.97051	-0.88767
West End	0.44929	0.72126	-1.02425	0.82236	-0.72192	-0.73766	1.33663	-0.4532
St. John								
Central	-0.589	0.32463	-0.42858	1.43133	-0.52731	-1.31504	1.96923	-0.35409
Coral Bay	-1.26707	0.01552	-0.35961	1.53076	-0.87863	-0.19824	-0.22281	-1.28198
Cruz Bay	0.88343	1.50369	0.61246	2.01276	-0.31105	-0.69705	-0.42825	0.35401
East End	-1.88012	0.61631	-0.78381	1.27712	-0.69856	1.71207	-0.52492	2.43993